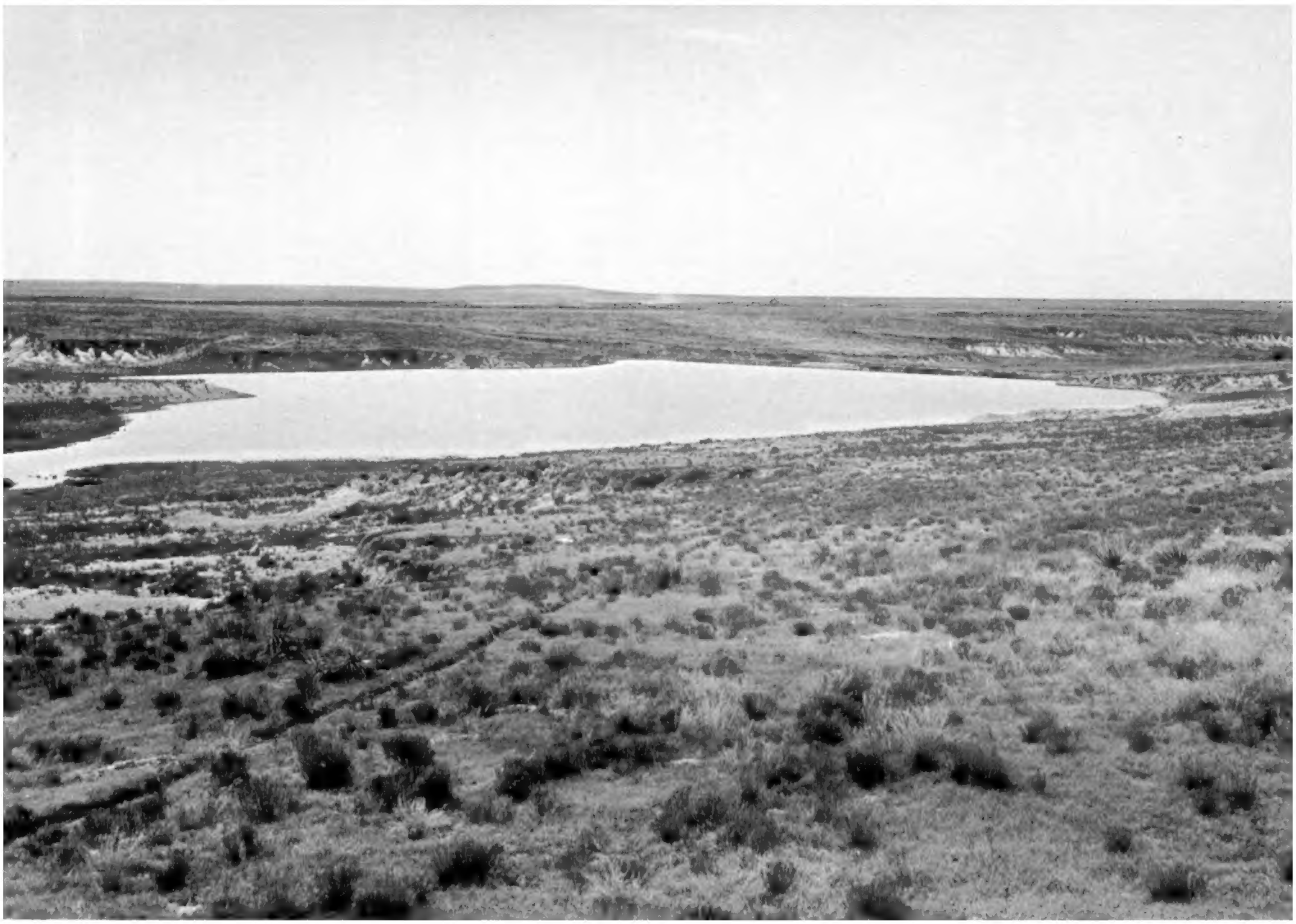
SOIL SURVEY OF

Lane County, Kansas



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Kansas Agricultural Experiment Station

Issued November 1972

Major fieldwork for this soil survey was done in the period 1959–64. Soil names and descriptions were approved in 1966. Unless otherwise indicated, statements in this publication refer to conditions in the county in 1964. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Lane County Soil Conservation District.

Either enlarged or reduced copies of the soil map in this publication can be made by commercial photographers, or they can be purchased on individual order from the Cartographic Division, Soil Conservation Service, USDA, Washington, D.C. 20250.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, ranching, industry, and recreation.

Locating Soils

All the soils of Lane County are shown on the detailed soil map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the range site and windbreak group in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the capability units, range sites, and windbreak groups.

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Fish and Wildlife Resources."

Ranchers and others can find, under "Range Management," groupings of the soils according to their suitability for range, and also the names of many of the plants that grow on each range site.

Engineers and builders can find, under "Use of the Soils in Engineering" tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Lane County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information in the section "General Facts About the County."

Cover: Farm pond in area of Ulysses, Penden, and Minnequa soils.

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Issued November 1972

SOIL SURVEY OF LANE COUNTY, KANSAS

BY KENNETH H. SALLEE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE KANSAS AGRICULTURAL EXPERIMENT STATION

LANE COUNTY is in the west-central part of Kansas (fig. 1). It has a land area of 720 square miles, or 460,800 acres. It extends about 30 miles from north to south and 24 miles from east to west. Dighton, the county seat, is in the center of the county.

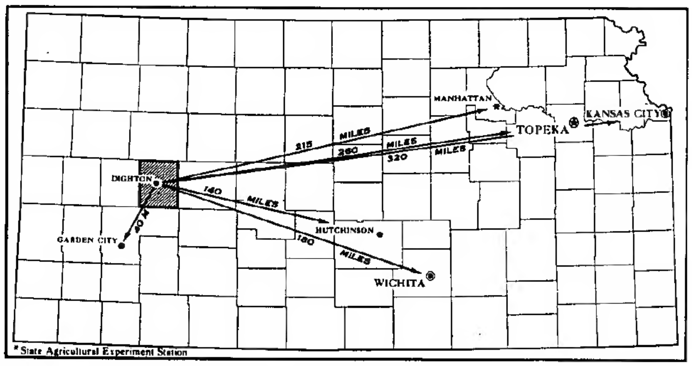

Figure 1.—Location of Lane County in Kansas.

The population and family income fluctuate as the result of prolonged periods of drought and periods of above-average rainfall. The population of the county in 1960 was about 3,150, and in the town of Dighton it was about 1,550.

Farming and ranching are the principal enterprises and sources of income. Wheat and grain sorghum are the main crops. Cattle is the main livestock. Most of the crops are grown under dryland farming, but during the past 60 years, irrigation has been practiced in the northern part of the county. About 5,500 acres is under irrigation. The principal crops grown under irrigation are corn, sorghum, wheat, and alfalfa. About 31 percent of the county is in native grass and is used as range. The acreage of native woodland is insignificant. The average size farm is about 1,200 acres. There are about 350 farms in the county.

Lane County is near the eastern edge of the Central High Plains section of the Great Plains physiographic province. Much of the western half and part of the eastern half are nearly level featureless plains dissected by drainageways. The northern edge and part of the eastern half of the county are gently sloping and rolling plains that are intersected by rough and broken areas along drainageways (fig. 2).

The nearly level to gently sloping tablelands are covered with loess. Richfield and Harney soils are the principal soils. These areas have an eastward slope of about 10 feet in 1 mile. Throughout these areas are many small to large undrained depressions, or lagoons. Ness soils occupy the lagoons.

The gently sloping to rolling areas along the drainageways are occupied by Richfield, Ulysses, and Penden soils. In the steeper, rough and broken areas are the Canlon and Campus soils. Along the northern edge of the county below the High Plains in the rough and broken areas are the Elkader and Minnequa soils and areas of Badland.

The valleys of the major drainageways are occupied by Bridgeport, Grigston, and Roxbury soils.

In the southwest corner of the county are undulating and hummocky sandhills. The soils are Otero and Tivoli soils. Joining these soils on the northeast on the floor of a large depression are the Church, Drummond, and Ness soils. The depression is joined on the south by gently sloping uplands and on the east and north by rolling and broken uplands.

The main streams in the county are Hackberry Creek and the South, Middle, and North Forks of Walnut Creek. Hackberry Creek drains the southeast corner of the county. The forks of Walnut Creek drain the central half. They originate in the western part and drain east into Ness County. The deeply entrenched drainageways along the north border of the county drain north into Gove County and join the Smoky Hill River.

The elevation of the tablelands ranges from about 2,880 feet in the western part to about 2,600 feet in the eastern part. Along the entrenched drainageways the elevation is 50 to 100 feet lower.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Lane County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it

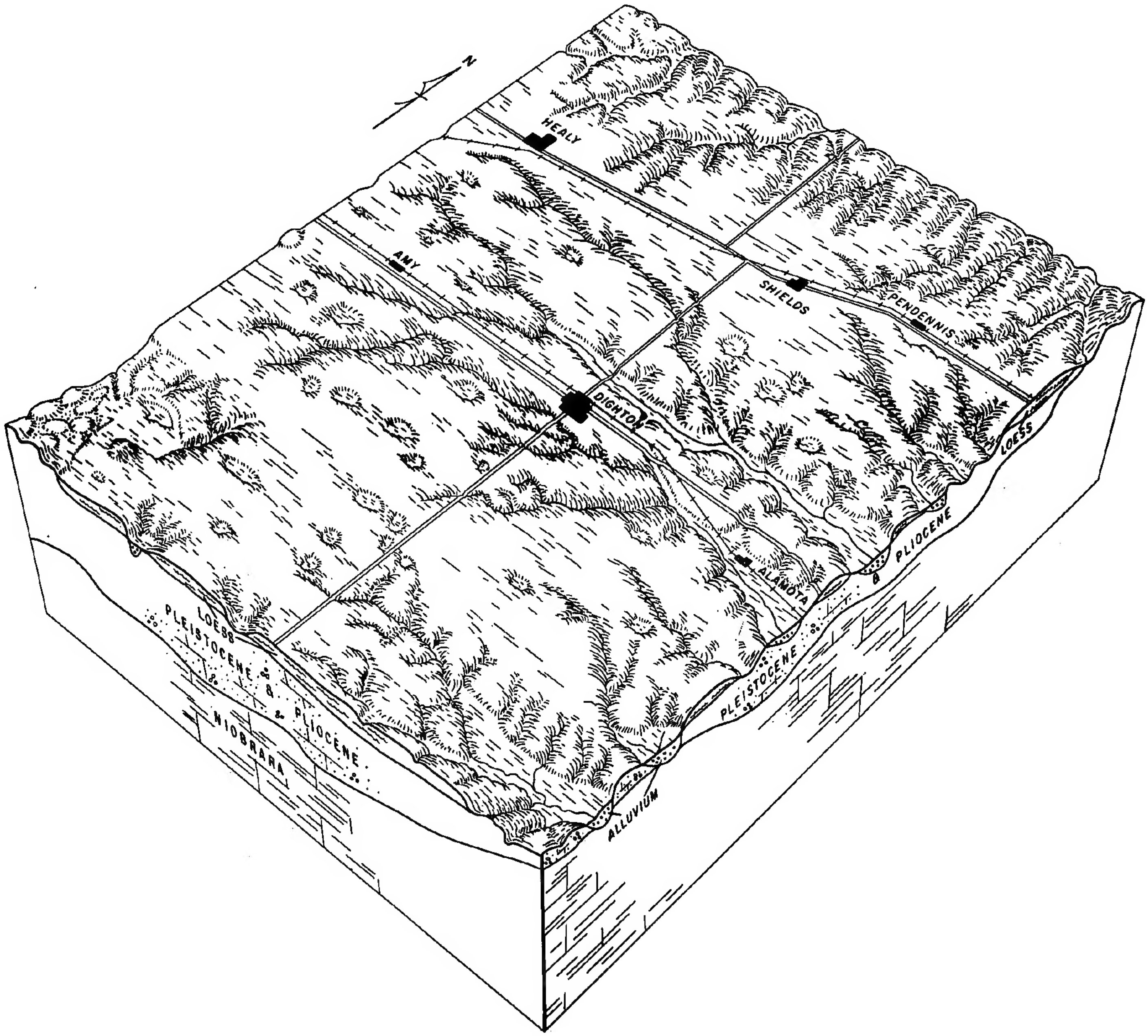

Figure 2.—Landscape of Lane County.

extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey (*16*).[1]

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Generally each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Richfield and Harney, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects manage-

[1] Italic numbers in parentheses refer to Literature Cited, page 61.

ment. For example, Ulysses silt loam, 3 to 6 percent slopes, is one of several phases within the Ulysses series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. One such kind of mapping unit is shown on the soil map of Lane County: a soil complex.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Canlon-Campus complex is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Alluvial land is a land type in Lane County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Lane County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The soil associations in Lane County are described in the following pages.

1. Richfield-Harney-Ulysses Association

Deep, nearly level to gently sloping, well-drained silt loams in the uplands

This association is on tableland that is dominantly nearly level but has low gently sloping ridges and knolls. It is about 48 percent Richfield soils, 46 percent Harney soils, and 4 percent Ulysses soils (fig. 3). It makes up about 61 percent of the county.

Richfield soils are nearly level to gently sloping and are on broad continuous areas and low ridges. Their surface layer is noncalcareous silt loam about 5 inches thick. The subsoil is silty clay loam. It is noncalcareous in the upper part but calcareous in the lower part. These soils have moderately slow permeability and a high available water capacity.

Harney soils are nearly level. They occupy broad, continuous areas, slightly concave in places, that have no clearly defined drainageways. Their surface layer is noncalcareous silt loam about 10 inches thick. The subsoil is silty clay loam. It is noncalcareous in the upper and middle parts but calcareous in the lower part. These soils have moderately slow permeability and a high available water capacity.

Ulysses soils are nearly level to gently sloping and occupy convex ridges and low knolls throughout the association. They have a surface layer of noncalcareous silt loam about 6 inches thick. The subsoil is light silty clay loam. It is noncalcareous in the upper part but calcareous in the lower part. These soils have moderate permeability and a high available water capacity.

The rest of this association consists of Ness soils on the floors of lagoons and undrained depressions, Grigston and Roxbury soils on the floors of swales, Colby soils on convex ridges and low knolls, and nearly level Keith soils on tablelands.

A large part of this association is used for dryland farming, and some large areas for native range. Wheat and grain sorghum are the main dryland crops. Inadequate rainfall is the principal limitation on the nearly level soils. Soil blowing is a slight hazard. Soil blowing and water erosion are hazards on the gently sloping soils.

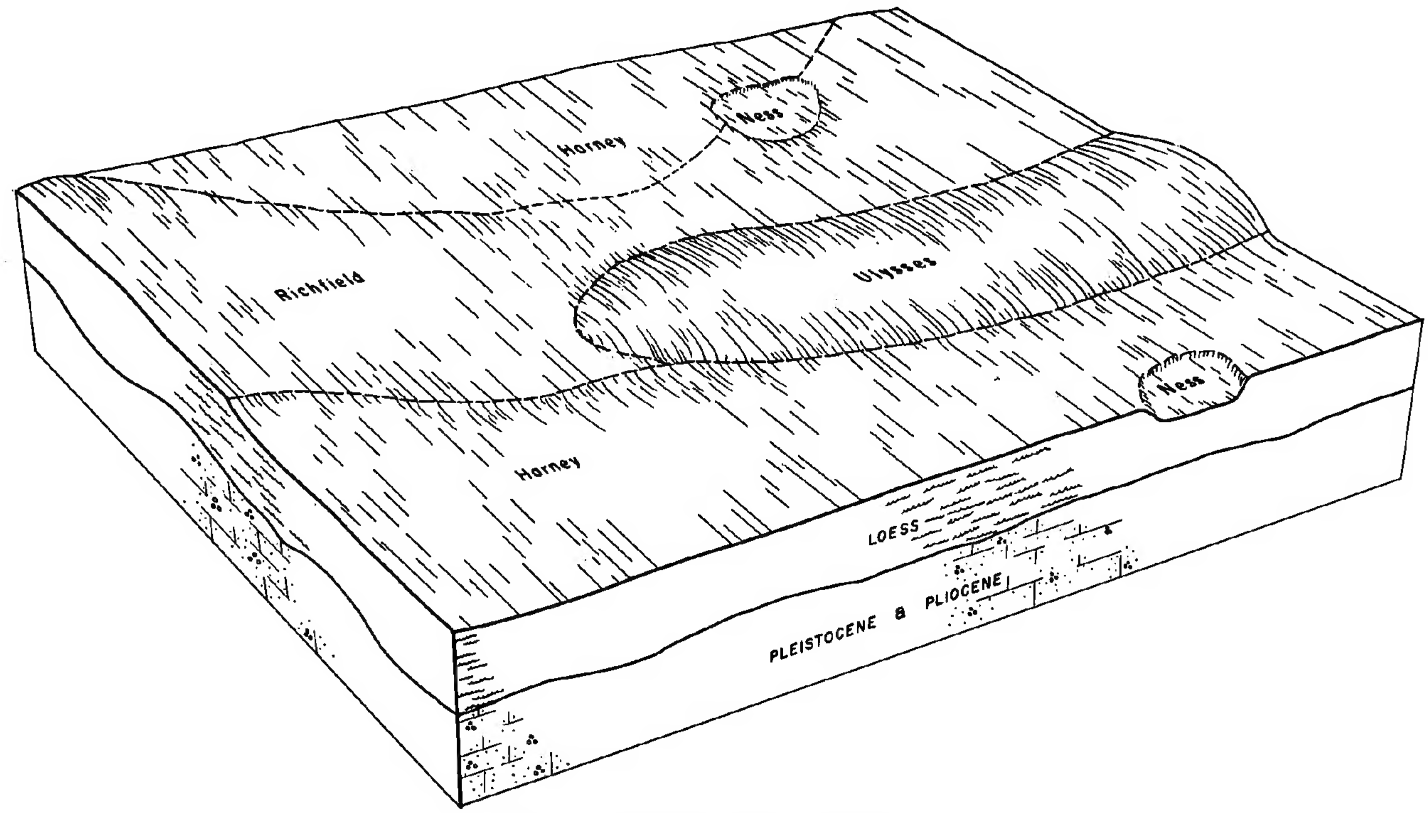

***Figure 3.*—Pattern of soils in association 1.**

Stubble mulching, level terraces, and contour farming help to control erosion and conserve moisture. Summer fallowing helps to store moisture for the following crop.

Most of the irrigated acreage in Lane County is in this association. Water is pumped from deep wells. The irrigated crops are corn, grain sorghum, forage sorghum, wheat, and alfalfa.

2. Penden-Richfield-Ulysses Association

Deep, nearly level to strongly sloping, well-drained clay loams and silt loams along drainageways in the uplands

This association is in rolling uplands that are dominantly gently sloping to strongly sloping. It is about 35 percent Penden soils, 28 percent Richfield soils, and 18 percent Ulysses soils (fig. 4). It makes up about 25 percent of the county.

Penden soils are gently sloping to strongly sloping and are on the sides of drainageways. They have a surface layer of calcareous clay loam about 9 inches thick. The underlying layers are strongly calcareous clay loam. These soils have moderately slow permeability and a high available water capacity.

Richfield soils are nearly level to sloping and are in the highest part of the landscape. They have a surface layer of noncalcareous silt loam about 5 inches thick. The subsoil is silty clay loam. It is noncalcareous in the upper part but calcareous in the lower part. These soils have moderately slow permeability and a high available water capacity.

Ulysses soils are gently sloping to strongly sloping and are on ridgetops and on sides of drainageways. They have a surface layer of noncalcareous silt loam about 6 inches thick. The subsoil is light silty clay loam. It is noncalcareous in the upper part and calcareous in the lower part. These soils have moderate permeability and a high available water capacity.

The rest of this association consists of Bridgeport, Grigston, and Roxbury soils and Alluvial land on the floors of drainageways, Harney and Keith soils on nearly level uplands, Kim and Colby soils on eroded slopes, Campus and Canlon soils and Badland on steep and broken slopes, and Ness soils on the floors of depressions.

This association is used for cropland and native range. Wheat and grain sorghum are the main crops. Most of the strongly sloping areas are in native grass. Soil blowing and water erosion are hazards on all of the sloping soils. Inadequate rainfall is the principal limitation on the nearly level soils. Soil blowing is a slight hazard. Stubble mulching, level terraces, and contour farming help to control erosion and conserve moisture. Summer fallowing is used to store moisture for the following crop. Proper range use is necessary to maintain the native grasses.

3. Ulysses-Penden-Minnequa Association

Deep and moderately deep, nearly level to strongly sloping, well-drained silt loams and clay loams in the rolling uplands

This association is in rolling uplands that are dominantly sloping and strongly sloping. Areas along drain-

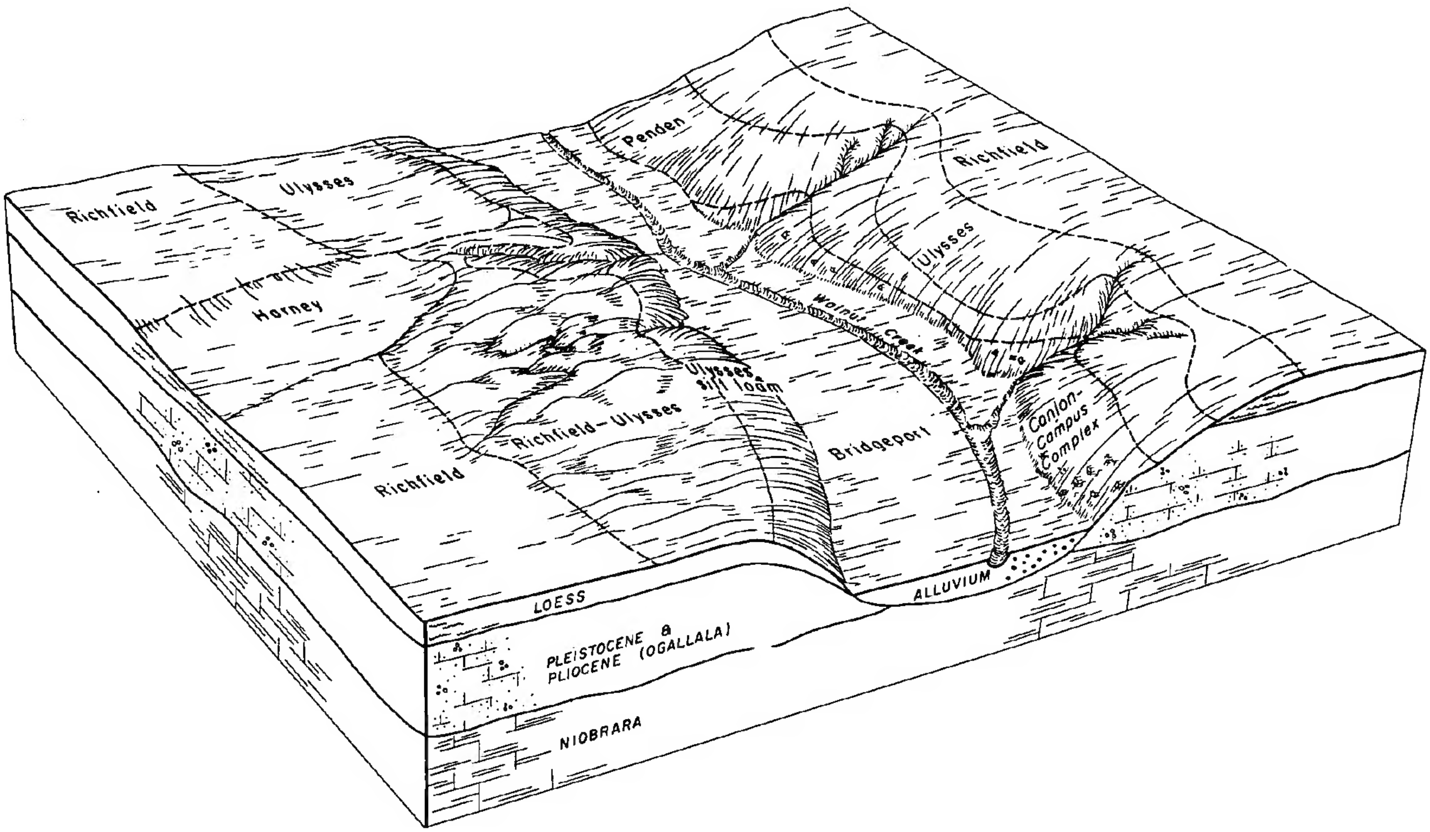

Figure 4.—Pattern of soils in association 2.

ageways are rough and broken (fig. 5). This association is about 34 percent Ulysses soils, 18 percent Penden soils, and 13 percent Minnequa soils. It makes up only about 13 percent of the county.

Ulysses soils are nearly level to strongly sloping and are on ridgetops in the higher parts of the association. They have a surface layer of noncalcareous silt loam about 6 inches thick. The subsoil is light silty clay loam. It is noncalcareous in the upper part and calcareous in the lower part. These soils have moderate permeability and a high available water capacity.

Penden soils range from gently sloping to strongly sloping but are dominantly strongly sloping. They occur below Ulysses soils. They have a surface layer of calcareous clay loam about 9 inches thick. The underlying layers are strongly calcareous clay loam. These soils have moderately slow permeability and a high available water capacity.

Minnequa soils are nearly level to gently sloping and occur with Badland along the drainageways in the lowest parts of the landscape. They have a surface layer of strongly calcareous clay loam about 4 inches thick. The underlying layers are strongly calcareous clay loam to a depth of about 31 inches. Below this is chalk rock. These soils have moderately slow permeability and a moderate available water capacity.

The rest of this association consists of Richfield soils on the higher areas along the southern edge of the association; Alluvial land and Bridgeport and Grigston soils on the floors of drainageways; Badland on barren, steep, rough, and broken areas; Elkader soils on gentle slopes below areas of Badland, Keith, and Harney soils in nearly level areas on uplands; Kim and Colby soils on sloping to strongly sloping ridges; Gravelly broken land on steep gravelly areas; and Canlon and Campus soils on high steep slopes where there are outcrops of caliche.

Most of the sloping and strongly sloping areas are used for native range, and most of the nearly level to gently sloping areas for wheat and grain sorghum. Water erosion is the dominant hazard, but soil blowing is also a hazard. Stubble mulching, level terraces, and contour farming help to control erosion and conserve moisture. Summer fallowing is used to store moisture for the following crop. Proper range use is necessary to maintain the native grasses.

The Ulysses-Penden-Minnequa association of Lane County joins the Colby-Mansker-Potter association of Scott County. Colby soils occur in both associations. The Campus soils of Lane County correspond with the Mansker soils of Scott County, and the Canlon soils of Lane County with the Potter soils of Scott County. There are no significant differences in use and management.

4. Church-Roxbury-Ness Association

Deep, nearly level, well-drained to poorly drained silty clay loams, silt loams, and clays on floors and benches in depressions

This association is on nearly level floors and benches in depressions. It is about 40 percent Church soils, 30

***Figure 5.*—Area of association 3. Minnequa soils are on the floor of the drainageway, and Badland on the sides of the drainageway. Penden soils are on uplands, above areas of Badland. Ulysses soils are on the outer higher slopes.**

percent Roxbury soils, and 15 percent Ness soils. It makes up less than 1 percent of the county.

Church soils are on the floor and outer edge of the floor of the depression. Their surface layer is calcareous silty clay loam about 7 inches thick. Below this is strongly calcareous silty clay loam, light clay, and clay loam that contain white crystalline salts. These soils are saline and alkali. They have moderately slow permeability and high available water capacity. Church soils have a water table that fluctuates between a depth of 2 and 10 feet.

Roxbury soils are on the outer edge of the depression on the slightly high bench. They have a surface layer of calcareous silt loam about 20 inches thick. Below this is calcareous silt loam underlain by clay loam and loam. These soils have moderate permeability and a high available water capacity.

Ness soils are on the floor of the depression. They have a surface layer of clay about 19 inches thick. Below this is silty clay, clay, and silty clay loam and masses of white crystalline salts. The Ness soils in this association are calcareous in all horizons and are high in salinity and alkali. Ponding is a hazard, and permeability is very slow.

The rest of this association consists of Drummond soils on the floor of the depression; Grigston soils on benches and alluvial fans entering the area; and Otero soils on low, narrow ridges fingering into the area; and an intermittent lake.

This association is used for both cropland and native range. Roxbury soils are well suited to crops. Church and Ness soils are not well suited to crops, but a large acreage is used for crop production. Grain sorghum, wheat, and alfalfa are the main crops. Soil blowing is a hazard. Stubble mulching is a protection measure. Proper range use is needed to maintain the native grasses.

5. Otero-Tivoli Association

Deep, undulating to hilly, well-drained to excessively drained sandy loams and loamy sands in the sandhills

This association is in undulating, hummocky, and hilly uplands. It is about 50 percent Otero soils and 50 percent Tivoli soils. It makes up less than 1 percent of the county.

Otero soils are in the undulating and hummocky part of this association, on the outer edge of the sandhills.

Their surface layer is calcareous fine sandy loam or loamy fine sand about 6 inches thick. Below this is calcareous fine sandy loam or loamy fine sand that has moderately rapid to rapid permeability. The available water capacity is moderate to low.

Tivoli loamy fine sand is in the hilly part of the association. Its surface layer is noncalcareous and is about 4 inches thick. The substratum is noncalcareous fine sand. This soil has rapid permeability and a low available water capacity.

Otero soils are used for cropland and native range. Grain sorghum is the most common crop. Soil blowing is the major hazard, and there are small areas of blowouts. Wind stripcropping, stubble mulching, and continuous cropping help protect these soils against blowing. Tivoli soils are used for native range. Proper range use is needed to maintain the native grasses.

The Otero-Tivoli association of Lane County joins the Tivoli-Vona association of Finney County. Vona soils do not occur in Lane County. The use and management of the two associations are similar. The Manter-Keith association of Finney County borders the Tivoli-Vona association but does not extend into Lane County.

Descriptions of the Soils

This section describes the soil series and the mapping units in Lane County. The procedure is first to describe each soil series and then the mapping units in that series. Thus, to get full information on any one mapping unit, it is necessary to read both the description of that unit and the description of the soil series to which it belongs.

Each soil series contains two descriptions of a soil profile. The first is brief and in terms familiar to a layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Alluvial land and Gravelly broken land, for example, do not belong to a series but, nevertheless, are listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit, the range site, and the windbreak group in which the mapping unit has been placed. The page on which each capability unit or range site is described can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the Glossary at the end of this survey.

Alluvial Land

Alluvial land (An) occurs on the narrow flood plains of drainageways. The narrow valley floors are cut by meandering stream channels. Slopes are 0 to 3 percent. The adjoining slopes are steep. The soils making up this land type consist of grayish-brown, calcareous loam to silty clay loam to a depth of about 4 feet. Below this is weakly stratified, loamy and sandy material. Included in mapping were small areas of Bridgeport, Grigston, and Roxbury soils on the broader nearly level areas, and in the northwestern part of the county a few sandy and gravelly areas.

Recurrent flooding and deposition are hazards. The available water capacity is high, and permeability is moderate to moderately slow. A few small areas are slightly to moderately affected by salt and alkali.

Native range is the principal use, as this land is well

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Area	Extent
	Acres	*Percent*
Alluvial land	3,430	0.7
Bridgeport silt loam, 0 to 1 percent slopes	1,700	.4
Bridgeport silt loam, saline	2,080	.5
Canlon-Campus complex	13,480	2.9
Church silty clay loam	1,250	.3
Drummond-Church complex	620	.1
Elkader silt loam, 1 to 4 percent slopes	690	.2
Gravelly broken land	740	.2
Grigston silt loam	1,470	.3
Harney silt loam, 0 to 1 percent slopes	121,710	26.4
Harney-Richfield complex, 0 to 1 percent slopes	9,050	2.0
Keith silt loam, 0 to 1 percent slopes	2,810	.6
Kim-Penden clay loams, 6 to 15 percent slopes, eroded	1,500	.3
Minnequa-Badland complex	8,040	1.7
Ness clay	4,090	.9
Otero fine sandy loam, undulating	640	.1
Otero soils, hummocky	770	.2
Penden clay loam, 1 to 3 percent slopes	830	.2
Penden clay loam, 3 to 6 percent slopes	3,400	.7
Penden clay loam, 6 to 15 percent slopes	43,720	9.4
Penden-Kim clay loams, 3 to 6 percent slopes, eroded	3,210	.7
Richfield silt loam, 0 to 1 percent slopes	102,810	22.3
Richfield silt loam, 1 to 3 percent slopes	43,310	9.4
Richfield-Ulysses silt loams, 1 to 3 percent slopes	31,100	6.8
Richfield-Ulysses silt loams, 3 to 6 percent slopes	2,060	.5
Roxbury silt loam	2,010	.4
Tivoli loamy fine sand	1,330	.3
Ulysses silt loam, 0 to 1 percent slopes	1,410	.3
Ulysses silt loam, 1 to 3 percent slopes	10,060	2.2
Ulysses silt loam, 3 to 6 percent slopes	10,250	2.2
Ulysses silt loam, 6 to 15 percent slopes	14,170	3.1
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	6,210	1.3
Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded	9,860	2.1
Ulysses-Colby silt loams, 6 to 15 percent slopes, eroded	710	.2
Intermittent lakes	280	.1
Total	460,800	100.0

suited to native grasses. Some of the sandy and gravelly areas are limited sources of sand and gravel for road building and other construction. (Dryland capability unit VIw-1; Loamy Lowland range site; Lowland windbreak group; no irrigated capability unit)

Badland

Badland consists of barren areas of chalk rock and shale. The areas are rough and broken and have numerous escarpments and vertical-walled canyons (fig. 6). In places the slope is as little as 2 percent. There is little or no soil development. Erosion removes soil material as fast as it forms.

The water intake rate is very slow. Surface runoff is very rapid, and the available water capacity is very low.

Vegetation covers less than 10 percent of this mapping unit. Small scrubby, woody plants are most common. There are a few, very small, isolated patches of blue grama and side-oats grama on the smoother, less erosive areas.

Badland can be used as wildlife habitat, watershed, and recreational areas. The Badland in Lane County is mapped only with Minnequa soils.

Bridgeport Series

The Bridgeport series consists of deep, nearly level, well-drained soils of the flood plains. These soils formed mainly in alluvium brought down from the upland.

In a representative profile the surface layer is grayish-brown, strongly calcareous silt loam about 11 inches thick. Below this is grayish-brown, strongly calcareous, friable light clay loam about 17 inches thick. The underlying material, to a depth of about 60 inches, is light brownish-gray, strongly calcareous heavy loam.

Bridgeport soils have a high available water capacity and moderate permeability.

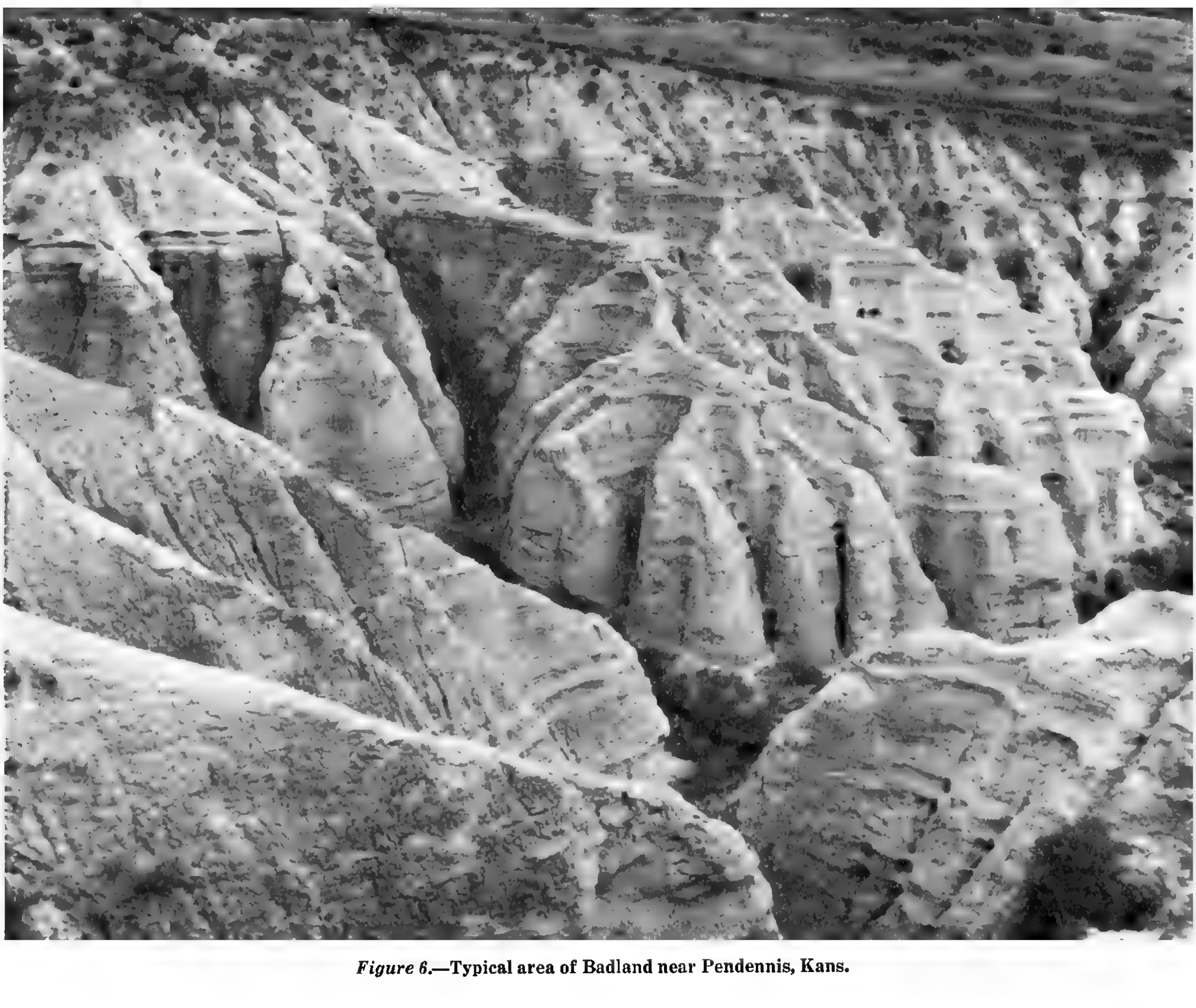

Figure 6.—Typical area of Badland near Pendennis, Kans.

Representative profile of Bridgeport silt loam, 0 to 1 percent slopes, about 2,320 feet west and 1,200 feet north of the southeast corner of section 19, T. 20 S., R. 27 W., in a cultivated field:

A1—0 to 11 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; nests and scattered worm casts; strongly calcareous; gradual, smooth boundary.

AC—11 to 28 inches, grayish-brown (10YR 5/2) light clay loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; many fine pores; many scattered worm casts; strongly calcareous; diffuse, smooth boundary.

C—28 to 60 inches, light brownish-gray (10YR 6/2) heavy loam, dark grayish brown (10YR 4/2) when moist; massive; slightly hard when dry, friable when moist; many fine pores; strongly calcareous.

The A1 horizon is gray or grayish brown in color and ranges from 6 to 17 inches in thickness. The A1 and AC horizons range from loam to light silty clay loam in texture. The C horizon is similar to the A1 and AC horizons except for stratified layers of sandy loam and heavy silty clay loam. The C horizon has colors of light brownish gray, grayish brown, or pale brown, and also, because of the stratification, colors of gray and dark grayish brown.

Bridgeport soils occur near Roxbury and Grigston soils. They differ from Grigston soils in having lime within a depth of 15 inches. The dark color extends to a lesser depth in these soils than in Roxbury soils.

Bridgeport silt loam, 0 to 1 percent slopes (Be).—This soil occurs on the low terraces of intermittent streams. Areas are between 5 and 30 acres in size. Some are dissected by entrenched stream channels. This soil has the profile described as representative for the series. Included in mapping were small areas of Roxbury and Grigston soils and of Bridgeport silt loam, saline.

Natural fertility is moderate to high. Inadequate rainfall is the principal limitation. Flooding is a hazard but generally causes little serious damage. The water table is generally below a depth of 10 feet during the growing season but rises to within 6 feet in winter and during periods of high rainfall.

This soil is used for cropland and range. It is well suited to the commonly grown crops and to alfalfa. (Dryland capability unit IIc–2; irrigated capability unit I–1; Loamy Terrace range site; Lowland windbreak group)

Bridgeport silt loam, saline (0 to 1 percent slopes) (Bg).—This soil occurs on low stream terraces. Areas are 5 to 100 acres in size. This soil is slightly to moderately saline and has white crystalline salts at various depths. Otherwise, it has a profile similar to that described as representative for the series. In many places there are gray-colored layers below a depth of 40 inches. Included with this soil in mapping were small areas of Roxbury and Grigston soils and small areas of alkali soil.

Drainage is moderately good to somewhat poor. Natural fertility is moderate to low. The water table fluctuates between depths of 2 and 10 feet. Flooding occurs about once every 3 years.

This soil is used for both rangeland and cropland. It is best suited to native grasses. (Dryland capability unit IVs–1; Saline Lowland range site; no irrigated capability unit or windbreak group)

Campus Series

The Campus series consists of nearly level to strongly sloping, well-drained soils that are moderately deep over hard caliche (fig. 7). These soils are on the upland. They formed in loamy outwash.

In a representative profile the surface layer is grayish-brown, strongly calcareous loam about 7 inches thick. Below this is light brownish-gray, strongly calcareous, friable loam about 12 inches thick. This layer is underlain by about 11 inches of very pale brown, strongly calcareous loam. At a depth of about 30 inches is hard, white caliche.

Campus soils have a low available water capacity and moderate permeability.

Representative profile of Campus loam in an area of Canlon-Campus complex, about 1,650 feet east and 1,520 feet north of the southwest corner of section 21, T. 18 S., R. 27 W., in native grass:

A1—0 to 7 inches, grayish-brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; numerous worm casts; few small hard fragments of caliche; strongly calcareous; gradual, smooth boundary.

AC—7 to 19 inches, light brownish-gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; numerous worm casts; many small to coarse fragments of caliche; strongly calcareous; gradual, smooth boundary.

Cca—19 to 30 inches, very pale brown (10YR 8/3) loam; massive; hard when dry, friable when moist; about 25 percent hard caliche fragments and 15 percent soft masses of lime; strongly calcareous; clear, smooth boundary.

R—30 inches, white (10YR 8/2), hard caliche; some soil material that is clay loam in texture in fractures and between pebbles.

The A1 horizon ranges from 5 to 12 inches in thickness and from sandy loam to clay loam in texture. The depth to caliche ranges from 20 to 40 inches. The depth to the Cca horizon is less than 24 inches.

Campus soils occur near Canlon, Kim, Minnequa, and Penden soils. They are deeper over hard caliche than Canlon soils. They have a higher concentration of caliche and calcium carbonate within a depth of 40 inches than Kim and Penden soils. They contain more sand than Minnequa soils and are not underlain by chalk.

The Campus soils in Lane County are mapped only with Canlon soils.

Canlon Series

The Canlon series consists of nearly level to steep, well-drained to excessively drained soils that are very shallow over hard caliche (fig. 8). These soils are on the upland. They formed in material weathered from the caliche.

In a representative profile the surface layer is grayish-brown, strongly calcareous loam about 5 inches thick. The next layer, about 5 inches thick, is a mixture of grayish-brown, strongly calcareous loam and hard caliche. Below this, at a depth of about 10 inches, is hard white caliche.

Canlon soils have a very low available water capacity and moderate permeability.

Representative profile of Canlon loam in an area of Canlon-Campus complex about 1,050 feet south and 400

Figure 7.—**Profile of Campus soil. The surface layer is clay loam. Soil is moderately deep over hard caliche.**

feet west of the northeast corner of section 9, T. 18 S., R. 27 W., in native grass:

A1—0 to 5 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; few small hard fragments of caliche; strongly calcareous; gradual, smooth boundary.

C—5 to 10 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; mixed with many hard fragments of caliche; strongly calcareous; abrupt, smooth boundary.

R—10 inches, white (10YR 8/1), hard caliche.

The depth to caliche ranges from 8 to 20 inches. The A1 and C horizons range from fine sandy loam to silt loam in texture and from light brownish gray to grayish brown in color. In places the R horizon is limestone, sandstone, or indurated, calcareous conglomerate.

Canlon soils occur near Campus and Minnequa soils. They are shallower over caliche than Campus soils. They are also shallower than Minnequa soils, which formed in material weathered from shale.

Canlon-Campus complex (1 to 40 percent slopes) (Cc).—This mapping unit is on the sides and crests of ridges along the drainageways. It is about 40 percent Canlon loam, 35 percent Campus loam, and 25 percent Penden clay loam. A typical area is nearly level on top of the ridge and breaks to strong, rough, broken slopes (fig. 9). Included in mapping were a few small areas of Minnequa and Ulysses soils, small areas of Badland, and barren, broken areas of caliche outcrop.

These soils have profiles similar to those described for their respective series.

Natural fertility is low for Canlon and Campus soils and moderate for Penden soils. Runoff is medium to rapid. Erosion is a hazard if the soils are not protected.

Nearly all the acreage is in range, because these soils are well suited to native grasses. (Dryland capability unit VIe-4 and Breaks range site for Canlon soils; Limy Upland range site for Campus and Penden soils; no irrigated capability unit or windbreak group)

Figure 8.—**Profile of Canlon loam. Soil is very shallow over hard caliche.**

Church Series

The Church series consists of deep, nearly level, somewhat poorly drained soils of the upland depressions. These soils formed in strongly calcareous, saline, lake-bed deposits or in old alluvium.

In a representative profile the surface layer is gray, calcareous silty clay loam about 7 inches thick. The next layer, about 8 inches thick, is gray, strongly calcareous, friable silty clay loam. The substratum extends to a depth of about 60 inches. It is light-gray, strongly calcareous, heavy silty clay loam in the uppermost part, light-gray, strongly calcareous, light clay in the middle part, and light-gray, strongly calcareous clay loam in the lowermost part.

Church soils have a high available water capacity and moderately slow permeability. Runoff is ponded for short periods. These soils have a fluctuating water table that is 2 to 10 feet below the surface. They are slightly to strongly affected by salt and alkali.

Representative profile of Church silty clay loam, about 1,400 feet north and 340 feet west of the southeast corner of section 20, T. 20 S., R. 30 W., in a cultivated field:

A1—0 to 7 inches, gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) when moist; massive; hard when dry, friable when moist; few roots; few open pores and few scattered worm casts in lower part; calcareous; clear, smooth boundary.

AC—7 to 15 inches, gray (10YR 6/1) silty clay loam, grayish brown (2.5Y 5/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; few roots; few open pores; many scattered worm casts; strongly calcareous; gradual, smooth boundary.

C1ca—15 to 26 inches, light-gray (2.5Y 7/2) heavy silty clay loam, grayish brown (2.5Y 5/2) when moist; moderate, fine, granular structure; very hard when dry, firm when moist; few roots; few fine open pores; few krotovinas; strongly calcareous; gradual, smooth boundary.

C2cs—26 to 34 inches, light-gray (2.5Y 7/2) light clay, light brownish gray (2.5Y 6/2) when moist; moderate, fine, granular structure; very hard when dry, firm when moist; masses of white crystalline salts; strongly calcareous; gradual, smooth boundary.

C3—34 to 60 inches, light-gray (2.5Y 7/2) clay loam, light brownish gray (2.5Y 6/2) when moist; massive to weak, fine, granular structure; hard when dry, friable when moist; strongly calcareous.

The A1 horizon ranges from 5 to 16 inches in thickness, from gray to grayish brown in color, and from heavy silt loam and silty clay loam to sandy clay loam in texture. The C horizon ranges from light gray to olive gray in color. Depth to white crystalline salts ranges from 26 to 60 inches. In most areas these soils are calcareous throughout, but in small, local areas they are noncalcareous to a depth of 15 inches. In places dark-colored material from the surface layer has filled deep vertical cracks that formed during dry periods.

The mean annual precipitation of the Church soils in Lane County is a few inches more than the range defined for the series, but this difference does not affect use and management.

Church soils occur near Ness, Drummond, Otero, and Roxbury soils. They are less clayey than Ness soils in the upper 36 inches of the profile; they are also somewhat better drained. They lack the columnar B2t horizon that is typical of Drummond soils. They are more clayey throughout the profile than Roxbury and Otero soils, and they are more poorly drained.

Church silty clay loam (0 to 1 percent slopes) (Ch).—This soil occur on the floors of depressions, as areas 50 to 700 acres in size. It has the profile described as representative for the series. Included with this soil in mapping were some small areas of soils similar to Otero soils except for more clayey underlying material; small areas of Ness and Drummond soils, most of which are in slight depressions; and small areas of Roxbury soils where drainageways from the uplands empty into areas of this soil.

Fertility is low to moderate. A seedbed is difficult to prepare because of the silty clay loam surface layer. The soil is slightly to moderately saline and in places is alkali. Flooding is a hazard, and occasionally a crop is drowned. Soil blowing is a hazard during periods of drought. The water table fluctuates between depths of 2 and 10 feet.

Most of the acreage is cultivated. Sorghum, wheat, and alfalfa are the principal crops. Because of the water table, alfalfa is grown under dryland management. (Dryland capability unit IVs–1; Saline Lowland range site; no irrigated capability unit or windbreak group)

Colby Series

The Colby series consists of deep, gently sloping to strongly sloping, well-drained soils of the upland. These soils formed in loess or in loamy sediments.

Figure 9.—Sloping area of Canlon-Campus complex along drainageway. Campus soils are in the gently sloping area in the foreground. Canlon soils are in the steeper areas. Outcrops of caliche occur on the more broken slopes.

In a representative profile, the surface layer is grayish-brown, calcareous heavy silt loam about 4 inches thick (fig. 10). It is underlain by light brownish-gray, strongly calcareous, friable light silty clay loam about 7 inches thick. The next layer, about 6 inches thick, is light-gray, strongly calcareous, friable light silty clay loam that contains concretions of soft lime. Below this, to a depth of 60 inches, is light-gray, strongly calcareous light silty clay loam.

Colby soils have a high available water capacity and moderate permeability. Runoff is medium to rapid.

Representative profile of Colby silt loam in an area of Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded, about 500 feet south and 400 feet west of the northeast corner of section 29, T. 18 S., R. 28 W., in a field formerly cultivated:

Ap—0 to 4 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many roots; calcareous; clear, smooth boundary.

AC—4 to 11 inches, light brownish-gray (10YR 6/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many fine roots; numerous worm casts; strongly calcareous; many fine open pores; gradual, smooth boundary.

C1ca—11 to 17 inches, light-gray (10YR 7/2) light silty clay loam, brown (10YR 5/3) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; few fine roots; many fine open pores; strongly calcareous; few soft masses of lime; diffuse, smooth boundary.

C2—17 to 60 inches, light-gray (10YR 7/2) light silty clay loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; many fine open pores; strongly calcareous.

The A horizon ranges from 2 to 6 inches in thickness, from grayish brown to pale brown in color, and from heavy silt loam to loam in texture. The AC and C horizons range from loam to light silty clay loam in texture. When dry, they range from light gray and light brownish gray to very pale brown in color. In most places this soil is calcareous in all horizons, but in some places the A horizon is noncalcareous.

Colby soils occur near Kim, Penden, and Ulysses soils. They have a thinner A horizon than Ulysses and Penden soils and lack the B2 horizon that is typical of Ulysses soils. They have less sand in the upper 40 inches of the soil profile than Kim and Penden soils.

The Colby soils in Lane County are mapped only with Ulysses soils.

Figure 10.—**Profile of Colby silt loam showing thin, dark-colored surface layer.**

Drummond Series

The Drummond series consists of deep, somewhat poorly drained, nearly level soils that occur on benches in depressions. These soils formed in old alluvium or in loamy and clayey, saline and alkali, lake-bed deposits.

In a representative profile the upper 3 inches of the surface layer is grayish-brown, noncalcareous, heavy loam. The lower 1 inch is gray, noncalcareous loam. The subsoil is about 9 inches thick. The uppermost 3 inches is grayish-brown, firm and compacted, heavy clay loam that is weakly calcareous in a few seams. The lowermost 6 inches is light brownish-gray, strongly calcareous, firm silty clay loam. The uppermost 7 inches of the substratum is light brownish-gray, strongly calcareous sandy clay loam. The next 15 inches is light brownish-gray, strongly calcareous silty clay loam. The next 19 inches is light brownish-gray, strongly calcareous sandy clay loam that is high in content of white crystalline salts. At a depth of 54 inches is light-gray, strongly calcareous silty clay loam that contains white crystalline salts and a few soft masses of calcium carbonate.

Drummond soils have a high available water capacity and slow permeability. Surface runoff is slow to ponded. The water table is 2 to 10 feet below the surface. The soil is strongly affected by salt and alkali.

Representative profile of Drummond loam in an area of Drummond-Church complex about 1,450 feet south and 300 feet west of the northeast corner of section 19, T. 20 S., R. 30 W., in native range:

A11—0 to 3 inches, grayish-brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; many roots; few pores; faint brownish staining on peds; noncalcareous; abrupt, smooth boundary.

A12—3 to 4 inches, gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; massive; hard when dry, very friable when moist; many roots; few pores; noncalcareous; abrupt, smooth boundary.

B2t—4 to 7 inches, grayish-brown (10YR 5/2) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, columnar structure breaking to moderate, fine and medium, subangular blocky; grayish films on upper surface of columns; very hard when dry, firm when moist; very compacted; many roots; weakly calcareous in a few seams; clear, smooth boundary.

B3—7 to 13 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine and medium, subangular blocky structure; very hard when dry, firm when moist; few roots; few fine pores; strongly calcareous; gradual, smooth boundary.

C1—13 to 20 inches, light brownish-gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; few roots; few fine pores; strongly calcareous; gradual, smooth boundary.

C2—20 to 35 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; moderate, fine, subangular blocky structure; very hard when dry, firm when moist; few roots; few fine open pores; strongly calcareous; gradual, smooth boundary.

C3cs—35 to 54 inches, light brownish-gray (10YR 6/2) sandy clay loam, grayish brown (10YR 5/2) when moist; massive; hard when dry, friable when moist; few fine pores; strongly calcareous; stratified layers high in white crystalline salts; gradual, smooth boundary.

C4cs—54 to 60 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; massive; hard when dry, friable when moist; few fine pores; strongly calcareous; few soft masses of calcium carbonate; few nodules of white crystalline salts.

The A1 horizon ranges from 2 to 8 inches in thickness and from fine sandy loam to clay loam in texture. When dry it is gray to grayish brown in color. Some profiles have an A2 horizon that ranges from a maximum thickness of 1½ inches to a thin coating capping the columnar structure of the B horizon. The B2 horizon ranges from 2 to 7 inches in thickness, from grayish brown to pale brown in color, and from clay loam to light clay in texture. Masses of white crystalline salts (gypsum) are common below a depth of 10 inches.

The annual temperature of the Drummond soils in Lane County is a few degrees cooler and the B2t horizon is thinner than the range defined for the series, but these differences do not affect use or management.

Drummond soils occur near Church, Ness, and Otero soils. Only the Drummond soils have a B2t horizon. In addition, Drummond soils are more clayey in all horizons than Otero soils and are less clayey in the upper 36 inches of the profile than Ness soils.

Drummond-Church complex (0 to 1 percent slopes) (Dc).—This mapping unit occurs on the floors of depres-

sions. It is about 65 percent Drummond loam and about 35 percent Church silty clay loam. Included in mapping were a few small areas of Otero soils, mostly on low ridges.

Both soils have profiles similar to those described for the respective series, except that in some areas the surface layer is sandy loam and in others it is clay.

These soils are strongly affected by salt and alkali. Natural fertility is low to moderate. The depth to the water table is between 2 and 10 feet. Flooding is a hazard during periods of high rainfall. During dry periods soil blowing is a hazard.

Nearly all the acreage is in range, as these soils are well suited to native grasses. (Dryland capability unit VIs-1; Saline Lowland range site; no irrigated capability unit or windbreak group)

Elkader Series

The Elkader series consists of deep, gently sloping, well-drained soils of the upland. These soils formed in strongly calcareous material weathered from marly chalk.

In a representative profile the surface layer is grayish-brown, calcareous heavy silt loam about 9 inches thick. Below this is light brownish-gray, strongly calcareous, friable light silty clay loam about 7 inches thick.

The substratum extends to a depth of about 60 inches. It is very pale brown, strongly calcareous silty clay loam and light silty clay loam. The lower part contains a few fine fragments of chalk rock.

Elkader soils have a high available water capacity and moderate permeability.

Representative profile of Elkader silt loam, 1 to 4 percent slopes, about 400 feet east and 400 feet south of the northwest corner of section 12, T. 16 S., R. 30 W., in native range:

A1—0 to 9 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; many roots; few fine open pores; few worm casts; calcareous; gradual, smooth boundary.

Bca—9 to 16 inches, light brownish-gray (10YR 6/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many fine open pores; many worm casts; few krotovinas; strongly calcareous; few soft lime concretions; gradual, smooth boundary.

C1ca—16 to 28 inches, very pale brown (10YR 7/3) silty clay loam, brown (10YR 5/3) when moist; weak, medium, granular and weak, fine, subangular blocky structure; hard when dry, friable when moist; few roots; many fine open pores; few clusters and scattered worm casts; few krotovinas; strongly calcareous; few soft lime concretions; diffuse, smooth boundary.

C2ca—28 to 60 inches, very pale brown (10YR 7/4) light silty clay loam, light yellowish brown (10YR 6/4) when moist; massive to weak granular structure; slightly hard when dry, friable when moist; few roots down to 40 inches; many fine open pores; strongly calcareous; few very fine threads and soft lime concretions; few fine fragments of chalk rock.

The A1 horizon ranges from dark grayish brown to brown in color and from 7 to 14 inches in thickness. All horizons range from silt loam to silty clay loam in texture. Some profiles do not have a Bca horizon.

Elkader soils occur near Minnequa, Ulysses, and Penden soils. They have a thicker, darker colored A horizon than Minnequa soils. In contrast with Ulysses soils, they are not underlain by loess. Also, they have more calcium carbonate within the upper 40 inches than Ulysses soils. They contain less sand than Penden soils.

Elkader silt loam, 1 to 4 percent slopes (Ek).—This soil is on lower slopes, below the level of the High Plains, in drainage tributaries to the Smoky Hill River. Areas are convex to slightly concave and are 10 to 100 acres in size. Included in mapping were a few small areas of Ulysses and Penden soils on higher slopes and small areas of Minnequa soils mostly on the lower smoother parts and on higher parts below escarpments.

Natural fertility is low. Runoff is rapid, not only because of the slope but also because the surface seals over and becomes slick during a rainstorm. Water erosion and soil blowing are serious hazards in cultivated areas.

Nearly all areas are in native range. Some are cultivated. (Dryland capability unit IIIe-3; Limy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Gravelly Broken Land

Gravelly broken land (10 to 40 percent slopes) (Gr) occurs on the hilly upland. It has steep, broken, convex slopes. The soils are strongly calcareous sandy loam, loamy sand, sand, and gravel. In most areas they are less than 20 inches deep over caliche, basal gravel, or conglomerate sandstone. These materials crop out in the broken areas. Included in mapping were small areas of Penden and Otero soils on the smoother slopes and of Canlon and Campus soils in the less sloping areas.

Drainage is good to excessive. Surface runoff is slow to rapid. Permeability is moderately rapid to rapid, and the available water capacity is very low to moderate. Erosion is a hazard if the soils are not adequately protected by vegetation.

Gravelly broken land is used for range. (Dryland capability unit VIIs-2; Gravelly Hills range site; no irrigated capability unit or windbreak group)

Grigston Series

The Grigston series consists of deep, nearly level, well-drained soils on benches, on stream terraces, and on the floors of swales in the upland. These soils formed in silty material washed down from nearby slopes.

In a representative profile the surface layer is dark grayish-brown, noncalcareous silt loam about 16 inches thick. The subsoil is light brownish-gray, weakly calcareous, friable silt loam about 8 inches thick. The substratum, to a depth of 48 inches, is light brownish-gray, strongly calcareous heavy silt loam that has threads and films of segregated lime. Below this, to a depth of about 60 inches, is pale-brown, calcareous silty clay loam.

Grigston soils have a high available water capacity and moderate permeability.

Representative profile of Grigston silt loam about 2,250 feet east and 400 feet south of the northwest corner of section 29, T. 20 S., R. 27 W., in a cultivated field:

A1—0 to 16 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate, medium, granular structure; slightly hard when dry,

friable when moist; many fine open pores; few worm casts; noncalcareous; gradual, smooth boundary.

B2—16 to 24 inches, light brownish-gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; many fine open pores; few worm casts; weakly calcareous; gradual, smooth boundary.

C1ca—24 to 48 inches, light brownish-gray (10YR 6/2) heavy silt loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, friable when moist; many fine open pores; few scattered worm casts; strongly calcareous with few threads and films of segregated lime; diffuse, smooth boundary.

C2—48 to 60 inches, pale-brown (10YR 6/3) silty clay loam, brown (10YR 4/3) when moist; massive; very hard when dry, firm when moist; calcareous.

The depth to free carbonates ranges from 15 to about 48 inches. The A horizon ranges from 10 to 20 inches in thickness and from loam to silt loam in texture. The B horizon ranges from silt loam to silty clay loam in texture and from fine granular to medium subangular blocky in structure.

Grigston soils occur near Bridgeport, Roxbury, Ulysses, Keith, Richfield, and Harney soils, but in lower positions than these soils. They are free of carbonates to a greater depth than Bridgeport, Roxbury, and Ulysses soils. They do not have the B2t horizon that is typical of Keith, Richfield, and Harney soils, and they have a less clayey B horizon than Richfield and Harney soils.

Grigston silt loam (0 to 1 percent slopes) (Gs).—This soil is on high terraces along streams, on benches in depressions, and on the floors of upland swales that collect and drain away runoff water from the upland soils. Individual areas are long and narrow and are between 5 and 100 acres in size. Included in mapping were a few small areas of Richfield, Keith, Harney, and Ulysses soils at the upper end of swales and drainageways and small areas of Bridgeport and Roxbury soils mostly along stream channels.

Natural fertility is high. Runoff is medium to slow. Inadequate rainfall is the principal limitation, but moisture that runs in from adjacent soils adds to the supply on this soil. Water erosion is a slight hazard. Soil blowing is a hazard if the soil is not protected by growing vegetation or residue.

This soil is used for cropland and rangeland. It is well suited to all commonly grown cultivated crops and to alfalfa. (Dryland capability unit IIc–2; irrigated capability unit I–1; Loamy Terrace range site; Lowland windbreak group)

Harney Series

The Harney series consists of deep, nearly level, well-drained soils on tablelands and in weakly depressional and concave areas in the upland. These soils formed in deep loess.

In a typical profile the surface layer is dark grayish brown and is 14 inches thick. The upper 10 inches is heavy silt loam, and the lower 4 inches is light silty clay loam. The subsoil extends to a depth of about 35 inches. It is dark grayish-brown, noncalcareous, firm silty clay loam in the uppermost part; grayish-brown, noncalcareous, firm, heavy silty clay loam in the middle part; and light brownish-gray, strongly calcareous, friable silty clay loam that contains soft masses of segregated lime in the lowermost part. Below this, to a depth of about 60 inches, is light-gray, strongly calcareous light silty clay loam.

Harney soils have a high available water capacity and moderately slow permeability.

Representative profile of Harney silt loam, 0 to 1 percent slopes, about 1,700 feet north and 60 feet east of the southwest corner of section 8, T. 17 S., R. 28 W., in a cultivated field:

A1—0 to 10 inches, dark grayish-brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; few roots; many fine open pores in lower part; few scattered worm casts; noncalcareous; upper 5 inches disturbed by plowing; gradual, smooth boundary.

A3—10 to 14 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark brown (10YR 2/2) when moist; moderate, fine, granular structure; slightly hard when dry, firm when moist; few roots; many fine open pores; many scattered worm casts; noncalcareous; gradual, smooth boundary.

B21t—14 to 19 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, subangular blocky structure; hard when dry, firm when moist; few roots; few very fine pores; shiny surfaces on peds; noncalcareous; gradual, smooth boundary.

B22t—19 to 26 inches, grayish-brown (10YR 5/2) heavy silty clay loam, dark grayish brown (10YR 4/2) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; few roots; few very fine pores; shiny surfaces on peds; noncalcareous; gradual, smooth boundary.

B3ca—26 to 35 inches, light brownish-gray (10YR 6/2) silty clay loam, grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; few fine pores; strongly calcareous with soft masses of segregated lime; diffuse, smooth boundary.

C1ca—35 to 51 inches, light-gray (10YR 7/2) light silty clay loam, grayish brown (10YR 5/2) when moist; weak, medium, subangular blocky structure; slightly hard when dry; friable when moist; many fine pores; calcareous with small soft masses, threads, and films of segregated lime; diffuse, smooth boundary.

C2—51 to 60 inches, light-gray (10YR 7/2) light silty clay loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; many fine pores; strongly calcareous.

The depth to lime ranges from 18 to 30 inches. The A1 horizon ranges from grayish brown to dark grayish brown in color, from silt loam to light silty clay loam in texture, and from 6 to 14 inches in thickness. The B2 horizon ranges from silty clay loam to light clay in texture.

Harney soils are near Richfield, Keith, Ulysses, Grigston, and Ness soils. The depth to lime is greater in Harney soils than in Richfield soils. Harney soils have a more clayey B2t horizon than Keith soils. They differ from Ulysses and Grigston soils in having a B2t horizon. They have a less clayey A horizon than Ness soils.

Harney silt loam, 0 to 1 percent slopes (Ha).—This soil occurs on broad tableland as areas between 200 and 5,000 acres in size. It has the profile described as representative for the series. Included in mapping were a few small areas of Richfield and Keith soils on slightly higher areas and small areas of Ness soils in depressions.

Natural fertility is high. Runoff is slow. Inadequate rainfall is the principal limitation, but crops often benefit from moisture that runs in from adjacent soils. Soil blowing is a slight hazard.

Nearly all the acreage is cultivated, because this soil is well suited to the commonly grown crops. (Dryland capability unit IIc–1; irrigated capability unit I–1; Loamy Upland range site; Silty Upland windbreak group)

Harney-Richfield complex, 0 to 1 percent slopes (Hr).—This mapping unit has slightly uneven topography. The difference in elevation between the lows and adjacent highs is less than 1 foot. Individual areas are between 50 and 700 acres in size. This unit is about 45 percent Harney soils, about 30 percent Richfield soils, about 15 percent Keith soils, and about 10 percent Ulysses soils. All of the soils have profiles similar to those described for the respective series. Included in mapping were small areas of Ness soils in slight depressions and a few areas where the surface layer is loam or light silty clay loam.

Natural fertility is high. Runoff is slow to medium. Inadequate rainfall is the principal limitation. Soil blowing is a slight hazard.

Much of the acreage is cultivated, but some large areas are in native grasses. The commonly grown crops are well suited. (Dryland capability unit IIc–1; irrigated capability unit I–1; Loamy Upland range site; Silty Upland windbreak group)

Keith Series

The Keith series consists of deep, nearly level, well-drained soils of the upland. These soils formed in loess.

In a representative profile the surface layer is grayish-brown, noncalcareous silt loam about 11 inches thick. The subsoil is about 14 inches thick. The upper part is dark grayish-brown, noncalcareous, friable light silty clay loam. The lower part is light-gray, friable light silty clay loam that contain soft masses of segregated lime. The substratum, to a depth of about 60 inches, is light-gray, calcareous silt loam that contains soft masses of lime.

Keith soils have a high available water capacity and moderate permeability.

Representative profile of Keith silt loam, 0 to 1 percent slopes, about 930 feet north and 60 feet east of the southwest corner of section 2, T. 16 S., R. 30 W., in native range:

A1—0 to 11 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak to moderate, fine, granular structure; slightly hard when dry, friable when moist; many roots; few fine pores; few scattered worm casts; gradual, smooth boundary.

B2t—11 to 19 inches, dark grayish-brown (10YR 4/2) light silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; many roots; many fine pores; few scattered worm casts; noncalcareous; gradual, smooth boundary.

B3ca—19 to 25 inches, light-gray (10YR 7/2) light silty clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; hard when dry, friable when moist; few fine roots; few pores; soil mass noncalcareous but contains soft concentrations of lime; gradual, smooth boundary.

C—25 to 60 inches, light-gray (10YR 7/2) silt loam, brown (10YR 5/3) when moist; massive; hard when dry, friable when moist; many fine pores; calcareous; soft masses of lime.

The A horizon ranges from 8 to 17 inches in thickness. The B horizon is 27 to 34 percent clay. The depth to calcareous material ranges from 16 to 30 inches. Darkened layers, which are remnants of a buried soil, occur in the lower part of the profile in some places.

Keith soils occur near Ulysses, Richfield, Harney, Ness, and Grigston soils. They differ from Ulysses soils in being more deeply leached of lime and in having a B2t horizon. They have a less clayey B2t horizon than Richfield and Harney soils. They are less clayey throughout the profile than Ness soils. They differ from Grigston soils in having a B2t horizon.

Keith silt loam, 0 to 1 percent slopes (Ka).—This soil occurs as slightly concave areas on the upland. Individual areas are between 15 and 150 acres in size. Included with this soil in mapping were small areas of Richfield, Ulysses, and Harney soils, which have slightly higher relief, and small areas of Ness soils in depressions.

Natural fertility is high. Runoff is slow. Inadequate rainfall is the principal limitation. Wind erosion is a slight hazard.

Most areas are under cultivation, as this soil is well suited to the commonly grown crops. (Dryland capability unit IIc–1; irrigated capability unit I–1; Loamy Upland range site; Silty Upland windbreak group)

Kim Series

The Kim series consists of deep, gently sloping to strongly sloping, well-drained soils of the upland. These soils formed in unconsolidated, calcareous outwash sediments.

In a representative profile the surface layer is grayish-brown, calcareous clay loam about 5 inches thick. Below this is about 4 inches of light brownish-gray, strongly calcareous clay loam that contains a few small concretions of lime. The next layer, about 22 inches thick, is pale-brown, strongly calcareous, firm clay loam. The underlying material, to a depth of about 60 inches, is pale-brown, strongly calcareous clay loam.

Kim soils have a high available water capacity and moderately slow permeability.

Representative profile of Kim clay loam in an area of Kim-Penden clay loams, 6 to 15 percent slopes, eroded, about 1,100 feet north and 300 feet east of the southwest corner of section 16, T. 17 S., R. 27 W.:

Ap—0 to 5 inches, grayish-brown (10YR 5/2) clay loam, brown (10YR 4/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many worm casts; calcareous; coarse sand grains; gradual, smooth boundary.

AC—5 to 9 inches, light brownish-gray (10YR 6/2) clay loam; brown (10YR 5/3) when moist; moderate, medium, granular structure; hard when dry, friable when moist; few fine pores; many worm casts; few small, soft and hard concretions of lime; strongly calcareous; coarse sand grains and a few pebbles; gradual, smooth boundary.

C1ca—9 to 31 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; moderate, medium, subangular blocky structure; very hard when dry, firm when moist; few fine pores; threads, films, and small, soft and hard concretions of lime; strongly calcareous; diffuse, smooth boundary.

C2—31 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; massive; hard when dry, friable when moist; many fine pores; small to medium, soft and hard concretionary masses of lime, which is part of the outwash parent material; strongly calcareous.

The Ap horizon ranges from 2 to 6 inches in thickness and from grayish brown to brown in color. In places there are scattered small rounded pebbles on the surface. In places remnants of buried soils occur at the surface or within the soil profile.

The Kim soils in Lane County have a slightly higher lime content in the C1ca and C2 horizons than the range defined for the series, but this difference does not alter use and management.

The Kim soils in this county are mapped with Penden soils. They have a thinner A horizon than Penden soils. Kim soils occur near Campus, Colby, and Ulysses soils. They have a lower concentration of calcium carbonate than Campus soils. They contain more sand in the upper 40 inches than Ulysses and Colby soils.

Kim-Penden clay loams, 6 to 15 percent slopes, eroded (Km).—This mapping unit occurs on the sides of ridges and the slopes along drainageways. It is about 60 percent Kim clay loam and about 40 percent Penden clay loam. Individual areas are between 20 and 300 acres in size. These soils have some characteristics like those described for the respective series, but in many areas, much of the Penden soil has a thinner surface layer than is typical of Penden soils. Also, in most places material from underlying horizons has been mixed into the plow layer of both soils. In some severely eroded spots light-colored, strongly calcareous material is exposed at the surface, and in places erosion has exposed dark-colored materials, which are remnants of buried soils. Included in mapping were a few small areas of Campus, Canlon, Richfield, Ulysses, and Colby soils.

Natural fertility is low to moderate. Runoff is rapid, not only because of the slope but also because the surface seals over during rainstorms. Erosion is a very severe hazard.

All the acreage is cultivated or has been cultivated. Some areas are so severely eroded they are no longer used for cultivated crops. (Dryland capability unit VI-3; Limy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Minnequa Series

The Minnequa series consists of nearly level to gently sloping, well-drained soils that are moderately deep over chalk rock. These soils are on alluvial fans. They formed in chalky, weathered sediments below outcrops of chalk rock.

In a representative profile the surface layer is light brownish-gray, strongly calcareous clay loam about 4 inches thick. Below this is about 4 inches of light-gray, strongly calcareous clay loam that contains fragments of chalk, shale, and fossilized material. This layer is underlain by pale-yellow, strongly calcareous, friable clay loam that contains fragments of chalk, shale, and fossilized material. At a depth of about 31 inches is relatively unaltered Smoky Hill Chalk of the Niobrara Formation.

Minnequa soils have a moderate available water capacity and moderately slow permeability.

Representative profile of Minnequa clay loam in an area of Minnequa-Badland complex, about 660 feet west and 1,190 feet north of the southeast corner of section 5, T. 16 S., R. 27 W., in native range:

A1—0 to 4 inches, light brownish-gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; weak, fine, granular structure; hard when dry, friable when moist; strongly calcareous; clear, smooth boundary.

AC—4 to 8 inches, light-gray (2.5Y 7/2) clay loam, grayish brown (2.5Y 5/2) when moist; few reddish-yellow mottles; weak, fine, granular structure; hard when dry, friable when moist; fragments of chalk, shale, and fossilized material; strongly calcareous: clear, smooth boundary.

C—8 to 31 inches, pale-yellow (2.5Y 7/4) clay loam, light olive brown (2.5Y 5/4) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; fragments of chalk, shale, and fossilized material; grains of aragonite and clear white silica; strongly calcareous; abrupt, smooth boundary.

R—31 inches, unaltered chalk rock.

The A1 horizon ranges from loam to silty clay loam in texture and from 2 to 6 inches in thickness. The depth to compacted, consolidated chalk ranges from 24 to 60 inches.

Minnequa soils occur near Elkader, Penden, Ulysses, Campus, and Canlon soils. They have a lighter colored, thinner A horizon than Elkader, Penden, and Ulysses soils. They contain less sand than Campus and Canlon soils and are not underlain by caliche.

The Minnequa soils in Lane County are mapped only with Badland.

Minnequa-Badland complex (Mb).—This mapping unit is nearly level to steep and is on the broken erosional upland (fig. 11). It is about 35 percent Minnequa clay loam and about 35 percent Badland. The Minnequa soil has the profile described for the series. Badland is described under the heading "Badland." Included in mapping were nearly level, strongly calcareous alluvial soils along drainageways, areas of gently sloping Elkader silt loam, and soils that have bedded chalk and shale within a depth of 4 to 20 inches but are otherwise like Minequa soils. The included alluvial soils consist of strongly calcareous loam, silt loam, or clay loam sediments on low flood plains. Flooding is a hazard, and each flood deposits fresh material.

Runoff is medium to rapid on Minnequa soils, and erosion is a hazard unless a grass cover is maintained. Runoff is very rapid on Badland, and erosion is severe.

All the acreage is used for native range. (Dryland capability unit VIIs-1 and Chalk Flats range site for Minnequa soils. Dryland capability unit VIIs-1 but no range site for Badland. No irrigated capability unit or windbreak group for either)

Ness Series

The Ness series consists of deep, nearly level, poorly drained soils on the floors of depressions throughout the upland. These depressions, locally called potholes, lagoons, or buffalo wallows, are enclosed and consequently have no surface drainage. The soils formed in alluvium or loess.

In a representative profile the upper 19 inches of the surface layer is gray, noncalcareous clay. The lower 16 inches is gray, noncalcareous, very firm silty clay that has a few very fine, faint, brownish mottles. The next layer, about 15 inches thick, is grayish-brown, noncalcareous heavy silty clay loam that contains soft concretions of segregated lime. The underlying material to a depth of about 60 inches is light-gray, noncalcareous silty clay loam that has fine threads of segregated lime between peds.

Ness soils have a high available water capacity. Internal drainage is very slow. Runoff is ponded. The substratum is typically more permeable than the overlying horizons.

Representative profile of Ness clay, about 2,120 feet east and 80 feet south of the northwest corner of section 15, T. 18 S., R. 28 W., in a field formerly cultivated:

A1—0 to 19 inches, gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; weak, thin, platy structure in uppermost 3 inches, weak, fine, blocky structure

below; extremely hard when dry, very firm when moist; noncalcareous; gradual, smooth boundary.

A12—19 to 35 inches, gray (10YR 5/1) silty clay, very dark gray (10YR 3/1) when moist; few, very fine, faint, brownish mottles; weak, fine, blocky structure; extremely hard when dry, very firm when moist; few fine open pores; noncalcareous; gradual, smooth boundary.

AC—35 to 50 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam to light clay, dark grayish brown (2.5Y 4/2) when moist; weak, coarse, prismatic structure breaking to weak blocky; very hard when dry, firm when moist; few very fine open pores; noncalcareous but contains a few soft concretions of segregated lime; gradual, smooth boundary.

C—50 to 60 inches, light-gray (10YR 7/2) silty clay loam, grayish brown (10YR 5/2) when moist; massive to weak granular structure; hard when dry, firm when moist; mass noncalcareous, but fine threads of segregated lime are common between peds.

The A horizon ranges from 20 to 40 inches in thickness and from gray to dark gray in color. It is silty clay or clay in texture. In some areas, mainly those adjacent to cultivated fields, the surface 2 to 4 inches is silt loam, as a result of deposition. The depth to the C horizon ranges from 36 to 50 inches. The C horizon ranges from light gray to light brownish gray in color and is silty clay loam or light silty clay in texture. The depth to calcareous material is commonly more than 30 inches.

Ness soils are generally surrounded by Harney, Richfield, Ulysses, Church, and Drummond soils. They have a thicker, more clayey A horizon than those soils, and they are more poorly drained.

Ness clay (0 to 1 percent slopes) (Ne).—This soil is on the floor of enclosed depressions that are a few inches to 10 feet below the surrounding soils. Individual areas range from 3 to 400 acres in size, but most are between 10 and 40 acres. Included in mapping in the larger areas were soils similar to Ness soils except that some have a light-gray surface layer and some are calcareous at or near the surface, and areas, in the large depression in the southwest corner of the county, where Ness clay is high in salt and alkali and has a fluctuating water table between depths of 2 and 10 feet.

***Figure 11.*—Area of Minnequa-Badland complex. The sloping vegetated areas are Minnequa and Elkader soils, and the outcrops of raw shale Badland.**

Drainage is poor, and runoff is ponded. The duration of ponding ranges from short periods to more than a year. The clay surface layer is difficult to till.

In many areas this Ness soil is cultivated along with the associated surrounding soils, but it is not well suited to crops or grass because of ponding. (Dryland capability unit VIw–2; no irrigated capability unit, range site, or windbreak group)

Otero Series

The Otero series consists of deep, undulating and hummocky, well-drained to excessively drained soils of the upland. These soils formed in strongly calcareous, outwash sediments that were reworked to some extent by wind.

In a representative profile the surface layer is light brownish-gray, calcareous fine sandy loam about 6 inches thick. Below this is pale-brown, calcareous, very friable fine sandy loam about 9 inches thick. The next layer is about 16 inches of very pale brown, strongly calcareous, very friable heavy fine sandy loam that has films, threads, and soft concretions of lime. The underlying material, to a depth of 60 inches, is very pale brown, strongly calcareous sandy loam stratified with loamy sand, loam, and clay loam.

Otero soils have a moderate to low available water capacity and moderately rapid to rapid permeability.

Representative profile of Otero fine sandy loam, undulating, about 1,920 feet south and 1,075 feet east of the northwest corner of section 19, T. 20 S., R. 30 W., in a field formerly cultivated:

A1—0 to 6 inches, light brownish-gray (10YR 6/2) fine sandy loam, dark grayish brown (10YR 4/2) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; many roots; calcareous; gradual, smooth boundary.

AC—6 to 15 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; many roots; many fine pores; calcareous; gradual, smooth boundary.

C1ca—15 to 31 inches, very pale brown (10YR 7/3) heavy fine sandy loam, brown (10YR 5/3) when moist; weak, fine, granular structure; slightly hard when dry, very friable when moist; few roots; many fine pores; films, threads, and soft concretions of lime; strongly calcareous; diffuse, smooth boundary.

C2—31 to 60 inches, very pale brown (10YR 7/3) heavy sandy loam, brown (10YR 5/3) when moist; stratified with loamy sand, loam, and clay loam; massive; soft when dry, very friable when moist; few pores; strongly calcareous.

The A1 horizon ranges from light loam to loamy fine sand in texture, from light brownish gray to brown in color, and from 3 to 8 inches in thickness. In areas where this horizon is brown, it is no thicker than 6 inches. The AC horizon ranges from loamy fine sand to sandy clay loam in texture.

Otero soils occur near Tivoli, Ulysses, Church, and Drummond soils. They are more sandy throughout the profile than Ulysses, Church, and Drummond soils but are less sandy than Tivoli soils. They also differ from Tivoli soils in being calcareous.

Otero fine sandy loam, undulating (3 to 8 percent slopes) (Of).—This soil has mostly convex slopes. It is on small knolls on the outer edge of the sandhills and on slopes along drainageways. It occurs in areas 10 to 200 acres in size. It has the profile described as representative for the series. Included in mapping were a few areas where the uppermost 1 to 3 inches of the surface layer is loamy fine sand; a few areas where the material below a depth of 40 inches consists of clayey lake-bed deposits; a few eroded areas where the surface layer is clay loam; small areas of Ulysses and Colby soils, mostly areas where the slope is less than 5 percent; and a few small blowouts.

Natural fertility is low. The available water capacity is moderate, and permeability is moderately rapid. Drainage is good. Soil blowing is a severe hazard in cultivated areas.

This soil is used for range and cropland. It is best suited to native grasses but can be used for crops if well managed. (Dryland capability unit IVe–1; Sandy range site; Sandy Upland windbreak group; no irrigated capability unit)

Otero soils, hummocky (5 to 15 percent slopes) (Oh).—This mapping unit has hummocky topography intermingled with small areas of low flats and undulating areas. It is about 50 percent Otero loamy fine sand, 40 percent Otero fine sandy loam, and 10 percent Tivoli loamy fine sand. Most areas are in the sandhills. Otero fine sandy loam has the profile described as representative for the Otero series. The other Otero soil is calcareous loamy fine sand to a depth of about 20 inches. The next 26 inches is calcareous light fine sandy loam. Below this, to a depth of about 60 inches, is calcareous loamy fine sand. Included in mapping were a few small areas of Colby soils and a few small blowouts.

Natural fertility is low. Otero loamy fine sand has a low available water capacity and excessive drainage. Otero fine sandy loam has a moderate available water capacity and good drainage.

Most of the acreage is in range, as the soils are well suited to native grasses. (Dryland capability unit VIe–2 for all three soils; no irrigated capability unit. Sands range site for Otero loamy fine sand and Tivoli loamy fine sand and Sandy range site for Otero fine sandy loam. Sandy Upland windbreak group for all three)

Penden Series

The Penden series consists of deep, gently sloping to strongly sloping, well-drained soils of the upland. These soils formed mainly in strongly calcareous unconsolidated outwash.

In a representative profile the upper 9 inches of the surface layer is grayish-brown, weakly calcareous clay loam. The lower 6 inches is grayish-brown, calcareous, friable clay loam. Below this is about 19 inches of pale-brown, strongly calcareous clay loam that contains threads, films, and concretions of lime (fig. 12). The substratum, to a depth of about 60 inches, is pale-brown, strongly calcareous clay loam.

Penden soils have a high available water capacity and moderately slow permeability.

Representative profile of Penden clay loam, 6 to 15 percent slopes, about 780 feet east and 80 feet north of the southwest corner of section 16, T. 17 S., R. 27 W., in native range:

A11—0 to 9 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many roots, many worm casts; weakly calcareous; gradual, smooth boundary.

Figure 12.—**Profile of a Penden clay loam showing concentration of lime.**

A12—9 to 15 inches, grayish-brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; hard when dry, friable when moist; many roots; many worm casts; few coarse sand grains; calcareous; gradual, smooth boundary.

C1ca—15 to 34 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; weak, medium, subangular blocky structure; very hard when dry, firm when moist; few fine roots, common fine pores; threads, films, and small soft and hard concretions of lime; strongly calcareous; diffuse, smooth boundary.

C2—34 to 60 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; massive; hard when dry, friable when moist; many fine pores; strongly calcareous.

The A1 horizon ranges from 6 to 20 inches in thickness and from grayish brown to dark grayish brown in color. It is commonly clay loam in texture, but in a few places it is silty clay loam. The A horizon is generally calcareous throughout, but in some profiles it is leached of lime to a depth of 6 inches. The C horizon ranges from brown to light gray in color. The carbonate content of the Cca horizon ranges from 15 to 25 percent.

Penden soils occur near Colby, Kim, Campus, Ulysses, and Richfield soils. They have a thicker A horizon than Colby and Kim soils. They lack the hard caliche that is typical of Campus soils. They contain more sand than Ulysses and Richfield soils and do not have the B2t horizon that is typical of Richfield soils.

Penden clay loam, 1 to 3 percent slopes (Pe).—This soil is on narrow ridges. Slopes are short and convex. Individual areas are between 10 and 40 acres in size. The profile of this soil is similar to the one described as representative for the series, but in areas of native grass the surface layer is about 2 inches thicker, and in cultivated areas it is commonly 2 inches thinner. Included with this soil in mapping were small areas of Campus, Kim, Ulysses, and Richfield soils.

Natural fertility is moderate. Runoff is medium. Erosion is a severe hazard in cultivated areas.

Most areas are cultivated, as this soil is suited to the commonly grown crops. (Dryland capability unit IIIe-1; irrigated capability unit IIe-1; Limy Upland range site; Silty Upland windbreak group)

Penden clay loam, 3 to 6 percent slopes (Pf).—This soil is on narrow ridgetops, on side slopes along drainageways, and on knolls. Slopes are convex. Individual areas are generally long and narrow and are between 10 and 600 acres in size. In areas of native grass the profile of this soil is similar to the one described as representative for the series, but in cultivated areas the surface layer is commonly 2 inches thinner. Included in mapping were small areas of Kim, Campus, Ulysses, Richfield, and Otero soils on similar slopes, and small areas of soils that are like Drummond soils but are underlain by limestone at a depth of 18 to 40 inches.

Natural fertility is moderate. Runoff is medium. Erosion is a severe hazard in cultivated areas.

This soil is used for native range and crops. If well managed, it is suited to all the commonly grown crops. (Dryland capability unit IVe-2; Limy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Penden clay loam, 6 to 15 percent slopes (Ph).—This soil occurs on ridges and on slopes along drainageways. It has the profile described as representative for the series. Individual areas are between 10 and 300 acres in size. Included with this soil in mapping were small areas of Kim, Campus, Canlon, Ulysses, Colby, and Elkader soils on similar slopes and small areas of soils that are like Drummond soils but are underlain by limestone at a depth of 18 to 40 inches.

Natural fertility is moderate. Runoff is rapid. Erosion is a very severe hazard in cultivated areas. Most of the acreage is used for native range, as this soil is well suited to native grasses. (Dryland capability unit VIe-3; Limy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Penden-Kim clay loams, 3 to 6 percent slopes, eroded (Pk).—This mapping unit occurs on the sides and crests of low, narrow ridges and on slopes along drainageways. It is about 60 percent Penden clay loam and about 40 percent Kim clay loam. Individual areas are between 10

and 400 acres in size. The surface layer of the Penden soil is a few inches thinner than is typical. In most places material from underlying horizons has been mixed into the plow layer. In places erosion has exposed dark-colored materials, which are remnants of buried soils. Otherwise, these soils are similar to those described as representative for their respective series. Included with these soils in mapping were small areas of Campus, Ulysses, Colby, Richfield, and Otero soils on similar slopes.

Natural fertility is low. Runoff is medium to rapid. Erosion is a severe hazard.

All areas have been cultivated. Some are now under cultivation. The soils are suited to the commonly grown crops if protective measures are used. (Dryland capability unit IVe–3; Limy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Richfield Series

The Richfield series consists of deep, nearly level to sloping, well-drained soils on the tableland and on knolls and ridges in the rolling upland. These soils formed in deep loess.

In a representative profile (fig. 13) the surface layer is grayish-brown, noncalcareous heavy silt loam about 5 inches thick. The subsoil, about 21 inches thick, is dark grayish brown, noncalcareous, friable silty clay loam in the uppermost part; grayish-brown, noncalcareous, firm heavy silty clay loam in the middle part; and in the lowermost part light brownish-gray, strongly calcareous, firm silty clay loam that contains many threads, films, and small soft concretions of lime. The underlying material, to a depth of about 51 inches, is light-gray, strongly calcareous light silty clay loam that has threads and films of lime. Below this to a depth of 60 inches, is light-gray, strongly calcareous light silty clay loam.

Richfield soils have a high available water capacity and moderately slow permeability.

Representative profile of Richfield silt loam, 0 to 1 percent slopes, about 1,620 feet west and 50 feet south of the northeast corner of section 1, T. 20 S., R. 28 W., in a cultivated field:

Ap—0 to 5 inches, grayish-brown (10YR 5/2) heavy silt loam, very dark grayish brown (10YR 3/2) when moist; weak, fine, granular structure; slightly hard when dry, friable when moist; noncalcareous; clear, smooth boundary.

B21t—5 to 9 inches, dark grayish-brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; weak, medium, prismatic structure breaking to weak subangular blocky; hard when dry, friable when moist; many fine open pores; few nests and scattered worm casts; noncalcareous; clear, smooth boundary.

B22t—9 to 17 inches, grayish-brown (10YR 5/2) heavy silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, prismatic structure breaking to moderate, fine to medium, subangular blocky; very hard when dry, firm when moist; shiny surfaces on peds; many fine open pores and root channels; noncalcareous to a depth of 15 inches; gradual, wavy boundary.

B3ca—17 to 26 inches, light brownish-gray (10YR 6/2) silty clay loam, dark grayish brown (10YR 4/2) when moist; weak, medium, subangular blocky structure; very hard when dry, friable when moist; few small krotovinas; numerous very fine open pores; strongly calcareous; many threads, films, and small soft concretions of calcium carbonate; diffuse, wavy boundary.

C1ca—26 to 51 inches, light-gray (10YR 7/2) light silty clay loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; few roots; numerous fine pores; few small krotovinas; threads and films of lime; strongly calcareous; diffuse, smooth boundary.

C2—51 to 60 inches, light-gray (10YR 7/2) light silty clay loam, brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; numererous fine pores; strongly calcareous.

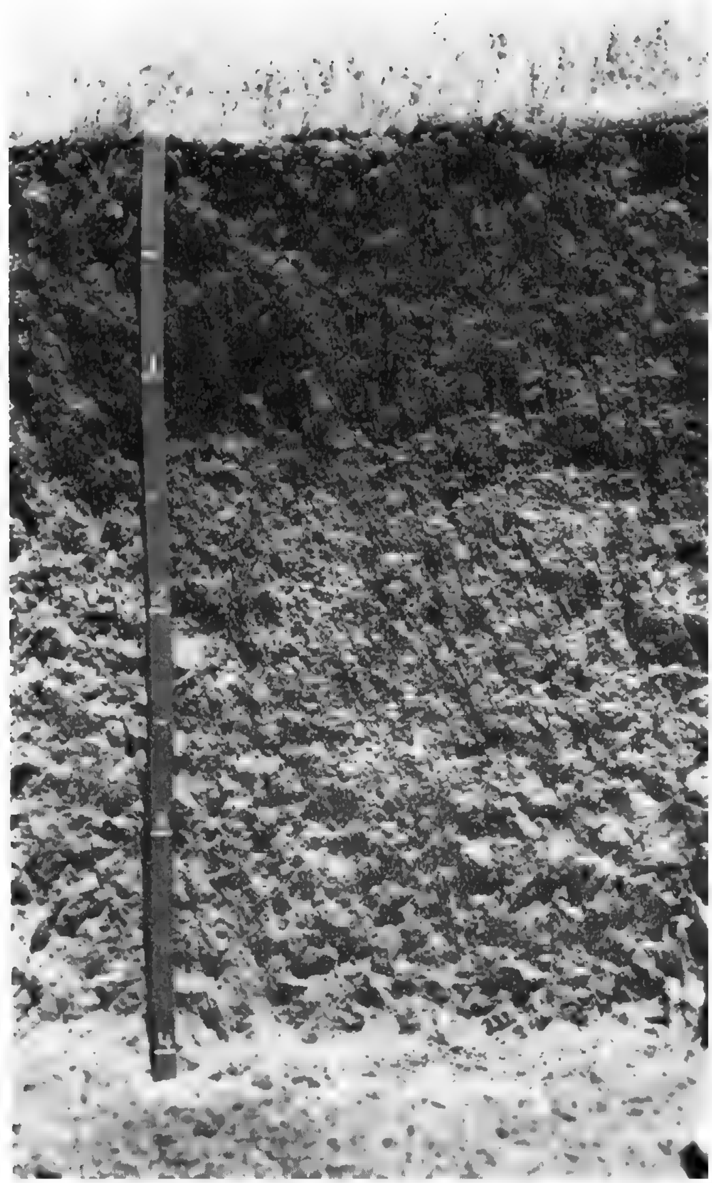

Figure 13.—Profile of Richfield silt loam, 1 to 3 percent slopes.

The depth to lime ranges from 10 to 18 inches. The A horizon ranges from silt loam to light silty clay loam in texture, from 4 to 10 inches in thickness, and from grayish brown to dark grayish brown in color. The B horizon ranges from silty clay loam to light silty clay in texture. In some places there is a dark-colored layer, a remnant of a buried soil, at a depth between 14 and 60 inches. The Richfield soils near Healy are generally shallower over calcareous material and

have a weaker developed profile than those in other parts of the county.

Richfield soils are near Harney, Keith, Ulysses, Ness, Grigston, and Penden soils. They are shallower over lime than Harney soils. They have a more clayey B2 horizon than Keith and Ulysses soils. They differ from Penden soils in having a B2t horizon and in containing less sand. Richfield soils have a thinner, less clayey A horizon than Ness soils and also have better drainage. They differ from Grigston soils in having a B2t horizon and in having a more clayey B horizon.

Richfield silt loam, 0 to 1 percent slopes (Rm).—This soil occurs on the tableland. It has the profile described as representative for the Richfield series. Individual areas are between 20 and 2,000 acres in size. Included in mapping were a few small areas of Harney and Keith soils in slightly concave areas, Ulysses soils in slightly higher areas, and Ness soils in small depressions.

Natural fertility is high. Runoff is slow. Inadequate rainfall is the principal limitation. Soil blowing is a slight hazard.

A large part of the acreage is cultivated, as this soil is well suited to the commonly grown crops. (Dryland capability unit IIc-1; irrigated capability unit I-1; Loamy Upland range site; Silty Upland windbreak group)

Richfield silt loam, 1 to 3 percent slopes (Rn).—This soil has convex slopes. It is on small knolls, on the tops of ridges, and on slopes along drainageways. Individual areas are between 30 and 200 acres in size. This soil is a little shallower over calcareous material than is typical of the series. Included with this soil in mapping were small areas of Ulysses, Colby, and Penden soils on similar slopes.

Natural fertility is high. Runoff is medium. Erosion is a hazard in cultivated areas.

Most of the acreage is cultivated, as this soil is suited to the commonly grown crops. (Dryland capability unit IIe-1; irrigated capability unit IIe-1; Loamy Upland range site; Silty Upland windbreak group)

Richfield-Ulysses silt loams, 1 to 3 percent slopes (Ro).—This mapping unit occurs on small knolls, on the tops of ridges, and on the gently undulating upland. It is about 65 percent Richfield silt loam and 35 percent Ulysses silt loam. Individual areas are between 10 and 1,000 acres in size. In the Richfield soil, the surface layer is about 4 inches of silt loam and the depth to lime is about 13 inches. In the Ulysses soil, the surface layer is about 5 inches thick and the depth to lime is about 7 inches. Otherwise, these soils are similar to those described as typical for the respective series. Included in mapping were small areas of Colby and Penden soils.

The Richfield soil has high natural fertility. The Ulysses soil has moderate natural fertility. Both have medium runoff. Erosion is a hazard in cultivated areas.

Much of the acreage is cultivated, but some large areas are in native range. The soils are suited to the commonly grown crops. (Dryland capability unit IIIe-1; irrigated capability unit IIe-1; Loamy Upland range site; Silty Upland windbreak group)

Richfield-Ulysses silt loams, 3 to 6 percent slopes (Rp).—This mapping unit occurs on knolls and sides of ridges in rolling areas of the upland. It is about 60 percent Richfield silt loam, 30 percent Ulysses silt loam, and 10 percent Penden clay loam. In the Richfield soil, the surface layer is about 4 inches of silt loam and the depth to lime is about 13 inches. In the Ulysses soil, the surface layer is about 5 inches thick and the depth to lime is about 7 inches. Otherwise, these soils are similar to those described as typical for the respective series. Included in mapping were small areas of Colby soils and small areas of a soil that is like the Richfield soil but has a substratum of calcareous outwash instead of loess.

The Richfield soil has high natural fertility. The Ulysses soil has moderate natural fertility. Both have medium runoff. Erosion is a severe hazard in cultivated areas.

About half the acreage is cultivated. The rest is in native range. The soils are well suited to the commonly grown crops. (Dryland capability unit IIIe-2; Loamy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Roxbury Series

The Roxbury series consists of deep, nearly level, well-drained soils that occur on benches in depressions, on high stream terraces, and in swales in the upland. These soils formed in silty material washed down from nearby slopes.

In a representative profile the surface layer is dark grayish-brown, calcareous silt loam about 20 inches thick. The subsoil is grayish-brown, calcareous, friable silt loam about 11 inches thick. The substratum to a depth of 52 inches is light brownish-gray, strongly calcareous light silty clay loam. Below this, to a depth of 60 inches, is light-gray, strongly calcareous loam.

Roxbury soils have a high available water capacity and moderate permeability.

Representative profile of Roxbury silt loam, about 1,600 feet north and 340 feet east of the southwest corner of section 3, T. 18 S., R. 27 W., in a nearly level, cultivated field:

A1—0 to 20 inches, dark grayish-brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; fine granular structure; slightly hard when dry, very friable when moist; many worm casts; calcareous; gradual, smooth boundary.

B2—20 to 31 inches, grayish-brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate, medium, granular structure; slightly hard when dry, friable when moist; few worm casts; many fine open pores; few krotovinas; calcareous; gradual, smooth boundary.

C1—31 to 52 inches, light brownish-gray (10YR 6/2) light silty clay loam, dark grayish brown (10YR 4/2) when moist; massive; hard when dry, friable when moist; many pores; numerous threads and films of lime; strongly calcareous; gradual, smooth boundary.

C2—52 to 60 inches, light-gray (10YR 7/2) heavy loam, grayish brown (10YR 5/2) when moist; massive; hard when dry, friable when moist; strongly calcareous.

The depth to lime is less than 12 inches. The A horizon ranges from loam to silty clay loam in texture and from 10 to 23 inches in thickness. The color is grayish brown, dark grayish brown, or dark gray. Below a depth of 20 inches the color ranges from brown to light gray. In the upper 40 inches the texture is silt loam or light silty clay loam.

Roxbury soils are near Bridgeport, Grigston, Ulysses, and Church soils. They differ from Grigston soils in having lime within a depth of 15 inches. They are less clayey throughout the profile and have better drainage than Church soils. The dark color extends to a greater depth in Roxbury soils than in Bridgeport and Ulysses soils.

Roxbury silt loam (0 to 1 percent slopes) (Rx).—This soil occurs on benches in depressions, on high stream terraces, and in swales in the upland. Individual areas are between 10 and 400 acres in size. Included in mapping were a few small areas of Ulysses and Penden soils along the outer edges of the areas mapped; areas of Bridgeport soils along stream channels; and areas of Grigston soils that receive extra moisture from higher slopes. In small areas associated with Bridgeport silt loam, saline, Roxbury silt loam is saline.

Natural fertility is high. Runoff is medium to slow. Inadequate rainfall is the principal limitation. In some areas runoff from surrounding slopes adds to the moisture supply. The water table is below a depth of 6 feet except during periods of high stream flow.

Much of the acreage is cultivated. This soil is suited to the commonly grown crops and to alfalfa. (Dryland capability unit IIc-2; irrigated capability unit I-1; Loamy Terrace range site; Lowland windbreak group)

Tivoli Series

The Tivoli series consists of deep, hummocky and hilly, excessively drained soils of the sandhills. These soils formed in deep, wind-deposited sand.

In a representative profile the surface layer is light brownish-gray, noncalcareous loamy fine sand about 4 inches thick. The next layer is about 7 inches of pale-brown, noncalcareous loamy fine sand. The underlying material, to a depth of about 60 inches, is very pale brown, noncalcareous, loose fine sand.

Tivoli soils have a low available water capacity and rapid permeability.

Representative profile of Tivoli loamy fine sand about 2,240 feet east and 320 feet north of the southwest corner of section 31, T. 20 S., R. 30 W., in native rangeland:

A1—0 to 4 inches, light brownish-gray (10YR 6/2) loamy fine sand, dark grayish brown (10YR 4/2) when moist; massive; soft when dry, very friable when moist; few roots; noncalcareous; clear, smooth boundary.

AC—4 to 11 inches, pale-brown (10YR 6/3) loamy fine sand, brown (10YR 5/3) when moist; massive; slightly hard when dry, very friable when moist; few roots; noncalcareous; gradual, smooth boundary.

C—11 to 60 inches, very pale brown (10YR 7/3) fine sand; brown (10YR 5/3) when moist; single grained; loose when dry and moist; noncalcareous.

The A1 horizon ranges from loamy fine sand to fine sand in texture, from grayish brown to pale brown in color, and from 3 to 6 inches in thickness.

Tivoli soils are near Otero soils. They differ from Otero soils in being noncalcareous and more sandy.

The annual temperature of the Tivoli soils in Lane County is a few degrees cooler than the range defined for the series, but this difference does not alter their use or management.

Tivoli loamy fine sand (5 to 20 percent slopes) (Ts).—This soil occurs on hilly sand dunes. Included in mapping were small areas of Otero soils in the less sloping areas and areas of small blowouts.

Natural fertility is low. Runoff is slow. Soil blowing occurs if the vegetation is inadequate.

The entire acreage is in native grasses and sand sagebrush. This soil is well suited to native grasses. (Dryland capability unit VIe-2; Sands range site; Sandy Upland windbreak group; no irrigated capability unit)

Ulysses Series

The Ulysses series consists of deep, nearly level to strongly sloping, well-drained soils of the upland. These soils formed in deep loess.

In a representative profile (fig. 14) the surface layer is grayish-brown, noncalcareous silt loam about 6 inches thick. The subsoil, about 10 inches thick, is grayish-brown, noncalcareous, friable light silty clay loam in the upper part and grayish-brown and light brownish-gray, calcareous heavy silt loam in the lower part. The underlying material, to a depth of about 60 inches, is light-gray, strongly calcareous heavy silt loam.

Ulysses soils have a high available water capacity and moderate permeability.

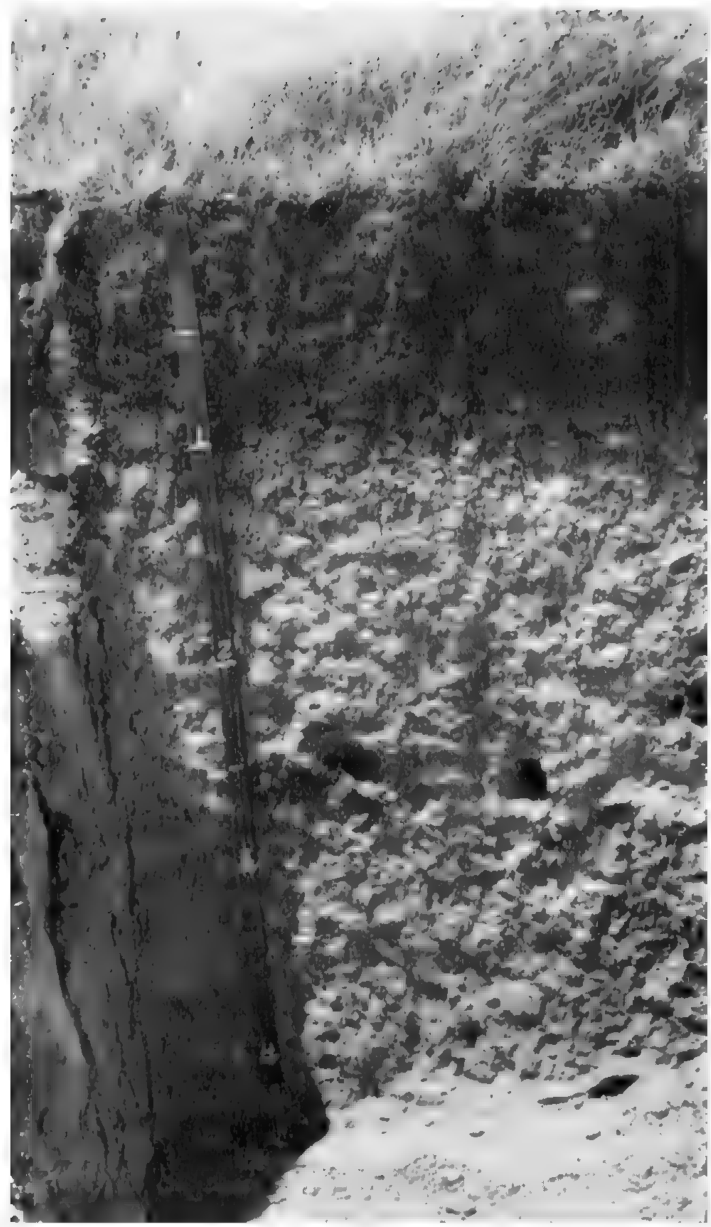

Figure 14.—**Profile of Ulysses silt loam, 1 to 3 percent slopes.**

Representative profile of Ulysses silt loam, 1 to 3 percent slopes, about 1,060 feet north and 5 feet west of the southeast corner of section 29, T. 18 S., R. 28 W., in native range.

A1—0 to 6 inches, grayish-brown (10YR 5/2) silt loam; very dark grayish brown (10YR 3/2) when moist; weak to medium, fine, granular structure; slightly hard when dry, friable when moist; many fine pores; many roots; noncalcareous; gradual, smooth boundary.

B2—6 to 11 inches, grayish-brown (10YR 5/2) light silty clay loam; very dark grayish brown (10YR 3/2) when moist; moderate, fine, granular structure; hard when dry, friable when moist; many fine roots; many fine pores; many scattered worm casts; noncalcareous; gradual, smooth boundary.

B3—11 to 16 inches, mixed colors of grayish brown and light brownish gray (10YR 5/2 and 6/2) heavy silt loam; dark grayish brown and brown (10YR 4/2 and 5/3) when moist; moderate, fine, granular structure; hard when dry, friable when moist; few roots; many fine pores; many scattered worm casts; calcareous, but no visible lime; gradual, smooth boundary.

C—16 to 60 inches, light-gray (10YR 7/2) heavy silt loam; brown (10YR 5/3) when moist; massive; slightly hard when dry, friable when moist; many fine pores; strongly calcareous.

The A horizon ranges from loam to light silty clay loam in texture and from 3 to 10 inches in thickness. The B horizon is light silty clay loam, silt loam, or clay loam. The depth to calcareous material is as much as 15 inches in some undisturbed areas, but some areas that have been cultivated are calcareous throughout the profile. Remnants of buried soils occur at various depths in some places.

Ulysses soils are near Richfield, Harney, Keith, Penden, Colby, Grigston, Roxbury, Elkader, Ness, Otero, and Kim soils. They have a less clayey B horizon than Richfield and Harney soils. They are not so strongly leached of lime as Grigston and Keith soils. They contain less sand than Penden soils. They differ from Colby soils in having a thicker A horizon and in having a B2 horizon. The dark color extends to a lesser depth in Ulysses soils than in Roxbury soils. Ulysses soils have a less clayey A horizon than Ness soils. They have a lower percentage of calcium carbonate within a depth of 40 inches than Elkader soils. They contain less sand in the uppermost 40 inches of the soil profile than Kim soils and less sand throughout the profile than Otero soils.

Ulysses silt loam, 0 to 1 percent slopes (Ua).—This soil is on the upland. Slopes are slightly convex. The individual areas are between 10 and 120 acres in size. The surface layer is about 5 inches thick in cultivated areas and is about 7 inches thick in areas under grass. Otherwise, the profile of this soil is similar to the one described as representative for the Ulysses series. Included in mapping were a few small areas of Harney, Richfield, and Keith soils in the slightly lower concave areas, and in eroded spots, areas of Colby soils.

Natural fertility is moderate to high. Runoff is slow. Inadequate rainfall is the principal limitation. Soil blowing is a hazard.

A large part of the acreage is cultivated. It is suited to the commonly grown cultivated crops. (Dryland capability unit IIc–1; irrigated capability unit I–1; Loamy Upland range site; Silty Upland windbreak group)

Ulysses silt loam, 1 to 3 percent slopes (Ub).—This soil occurs as convex slopes of low ridges and knolls and as slopes along drainageways. It has the profile described as representative for the series. Individual areas are between 10 and 1,400 acres in size. Included in mapping were small areas of Richfield, Penden, and Colby soils.

Natural fertility is moderate. Runoff is medium. Erosion is a hazard in cultivated areas.

Many areas are cultivated. The soil is well suited to the commonly grown crops. (Dryland capability unit IIIe–1; irrigated capability unit IIe–1; Loamy Upland range site; Silty Upland windbreak group)

Ulysses silt loam, 3 to 6 percent slopes (Uc).—Most areas of this soil are along drainageways. Individual areas are between 10 and 1,000 acres in size. This soil has the profile described as representative for the series except that in cultivated areas the surface layer is about 4 inches thick and all horizons are calcareous. In areas under grass the depth to lime is about 8 inches. Included with this soil in mapping were small areas of Richfield and Penden soils on similar slopes, and on the stronger slopes small areas of Colby and Campus soils.

Natural fertility is moderate. Runoff is medium. Both water erosion and soil blowing are severe hazards in cultivated areas.

This soil is used for cropland and range. It is suited to the commonly grown cultivated crops if managed properly. (Dryland capability unit IVe–2; Loamy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Ulysses silt loam, 6 to 15 percent slopes (Ud).—Most areas of this soil are along drainageways. Individual areas are between 10 and 1,200 acres in size. Most are irregular in shape. Except for a 4-inch surface layer, a silt loam subsoil, and lime at a depth of about 7 inches, this soil has the profile described as representative for the series. Included in mapping were small areas of Colby, Elkader, Penden, and Campus soils, some long narrow areas of alluvial soils on floors of drainageways, and soils that are similar to Ulysses soils but have clay loam outwash below a depth of 36 inches.

Natural fertility is moderate to low. Runoff is medium to rapid. Water erosion is a severe hazard unless the soils are well managed.

Nearly all the acreage is used as rangeland. The soil is well suited to native grasses. (Dryland capability unit VIe–1; Loamy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded (Ue).—This mapping unit has convex slopes. It occurs on low ridges and knolls and along drainageways. It is about 70 percent Ulysses silt loam and 30 percent Colby silt loam. The Colby soil occurs in the most eroded parts. Individual areas are between 10 and 300 acres in size. Included in mapping were small areas of Richfield and Penden soils.

These soils have profiles similar to those described for their respective series except that the surface layer of Ulysses soil is thinner, in most places material from the underlying horizons has been mixed into the plow layer, and in some of the most eroded areas calcareous silty clay loam material is exposed at the surface.

Natural fertility is moderate to low. Runoff is medium. Both water erosion and soil blowing are hazards unless the soils are well managed.

Nearly all the acreage is cultivated. The soils are suited to most of the commonly grown crops. Sorghum is subject to chlorosis. (Dryland capability unit IIIe–3; irrigated capability unit IIe–1; Limy Upland range site; Silty Upland windbreak group)

Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded (Um).—This mapping unit occurs mostly along upland

drainageways. It is about 60 percent Ulysses silt loam and 40 percent Colby silt loam. The Colby soil is in the more eroded parts. The individual areas, most of which are long and narrow, are between 10 and 200 acres in size. Included in mapping were small areas of Richfield and Penden soils.

These soils have profiles similar to those described as representative for their respective series except that the surface layer of the Ulysses soil is thinner, in most places material from the underlying horizons has been mixed into the plow layer, and in some of the most eroded areas calcareous silty clay loam material is exposed at the surface.

Natural fertility is moderate to low. Runoff is medium. Both water erosion and soil blowing are severe hazards unless the soils are well managed.

Nearly all the acreage is cultivated. The soils are suited to most of the commonly grown crops. Sorghum is subject to chlorosis. (Dryland capability unit IVe-3; Limy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Ulysses-Colby silt loams, 6 to 15 percent slopes, eroded (Un).—This mapping unit occurs mostly on sides of ridges and along upland drainageways. It is about 60 percent Ulysses silt loam and 40 percent Colby silt loam. The Colby soil is in the more eroded parts. Individual areas are between 10 and 700 acres in size. Included in mapping were areas of Richfield, Penden, Elkader, and Campus soils and long narrow areas of alluvial soils on floors of drainageways.

These soils have profiles similar to those described as representative for their respective series except the surface layer of the Ulysses soil is thinner, in most places material from the underlying horizons has been mixed into the plow layer, and in some of the most eroded areas calcareous silty clay loam material is exposed at the surface.

Natural fertility is low. Runoff is medium to rapid, and erosion has been moderate. Both water erosion and soil blowing are very severe hazards unless the soils are well managed.

Nearly all the acreage is cultivated or has been cultivated. The soils are best suited to native grasses. (Dryland capability unit VIe-3; Limy Upland range site; Silty Upland windbreak group; no irrigated capability unit)

Effects of Erosion

Erosion is the removal of soil and geologic material by wind, running water, and gravity. Accelerated soil erosion, which should not be confused with natural geologic erosion, is brought about by changes in the natural cover or condition of the soil that were caused by the activities of man (fig. 15).

Wind erosion, or soil blowing, is a continuous hazard in Lane County, and the hazard becomes more serious during periods of drought. High wind velocity, limited vegetation, and soil blowing are characteristic of periods of drought on the High Plains.

Water erosion is a hazard on all the cultivated, sloping silty soils. It is most likely during hard thunderstorms, when rain falls more rapidly than it can be absorbed.

Some effects of erosion are permanent and so serious that changes in use and management of the soils are necessary. Others impair the soils only temporarily.

During the fieldwork on this soil survey, the following effects of erosion were observed.

1. The tops of ridges and knolls are more susceptible to blowing than the adjacent, nearly level soils. Much of the material blown from these exposed areas is deposited on smoother soils nearby, but some of the finer soil particles are blown great distances. Much of the silt and sand deposited on the adjacent areas is calcareous and is more likely to blow than noncalcareous material.
2. Soil material tends to drift from actively eroding cultivated land onto adjacent rangeland, where it damages and destroys the vegetation. The value of such areas for grazing is impaired until the grass is restored by reseeding or deferment of grazing.
3. Sloping soils are susceptible to water erosion in areas not protected by growing plants, plant residue, or mechanical structures. The sloping, calcareous loamy soils are highly erodible because they tend to seal over during a rainstorm. In many places erosion has removed the surface layer and the subsoil and has exposed the underlying calcareous material.
4. Damage from scouring and deposition on bottom land soils is a result of water erosion on upland soils.
5. Overgrazing of sandy rangeland during a drought destroys the protective vegetation. If the soils are exposed, blowing damages them permanently and impairs their value for grazing. Also, the drifting sand damages cultivated crops and grass in nearby areas and increases the hazard of blowing in the areas where it is deposited.
6. Moderate erosion has damaged about 5 percent of the acreage in Lane County to the extent that it has modified soil characteristics significant to use and management.

Erosion is serious not only because of permanent damage to soils but also because of temporary damage to crops and forage. The temporary damage can be overcome by replanting crops, reseeding range, emergency tillage, and land smoothing, but such operations are costly and time consuming.

The combinations of practices needed to control erosion vary according to the kind of soil, the degree of slope, and the use of the soil. Management needs and appropriate practices are discussed in the sections "Decriptions of the Soils" and "Use and Management of the Soils."

Use and Management of the Soils

This section explains the capability classification used by the Soil Conservation Service, describes the general management in Lane County and the management by capability unit for both dryland and irrigated crops, and gives predicted yields of dryland and irrigated crops under high level management for the arable soils in the

Figure 15.—**Soil erosion on a Ulysses silt loam after grain sorghum was planted up and down the slope. Planting on the contour or protecting the field with terraces would have reduced erosion significantly.**

county. This section also gives suggestions on management of the soils for range, windbreaks, and wildlife habitat, and tells about the use of the soils in engineering.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, all kinds of soils are grouped at three levels: the capability class, the subclass, and the unit. These are discussed in the following paragraphs.

Capability Classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use. There are no class I soils in Lane County.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat. There are no class V soils in Lane County.

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife habitat.

Class VIII soils and landforms have limitations that preclude their use for commercial plant production, and restrict their use to recreation, wildlife habitat, or water supply, or to esthetic purposes. There are no class VIII soils in Lane County.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making any statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-4 or IIIe-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

In the following pages are suggestions on general management and management by capability unit of the dryland and irrigated soils in Lane County.

General Management of Dryland Soils [2]

When the soils of Lane County were covered with native grass, rain and wind did little damage because the soils were protected by living plants or plant residue. Rainwater was absorbed rapidly, and there was little runoff.

Cultivation, especially cultivation in nonirrigated areas, reduced the supply of organic matter and damaged soil structure and tilth in many places. Areas that were left bare became susceptible to both water erosion and soil blowing.

The major management needs in this county are conservation of moisture, control of erosion, maintenance of fertility, and preservation of tilth. The practices now used are based on protecting the soils with growing crops or crop residue at all times. Effective conservation measures applicable to all cropland in the county include a conservation cropping system, minimum tillage, and utilization of crop residue, by stubble mulching and controlled grazing, for example. Terracing and contour farming are helpful in reducing runoff and erosion and in conserving moisture. Stripcropping controls soil blowing in most places.

Low rainfall limits the choice of dryland crops. Winter wheat and grain sorghum are the two principal dryland crops grown in the county. The most common cropping system, or sequence, is summer fallow, winter wheat, and grain sorghum. Summer fallow, which stores moisture for crops grown in the following season, is considered a necessary part of most cropping systems used in the county.

Crop production in this county is sometimes uncertain, even when summer fallow is used. For this reason a practice such as stubble-mulch farming is needed to help control soil blowing and water erosion (fig. 16). Stubble-mulch farming is a system of residue management in which harvesting, seedbed preparation, planting, and any subsequent cultivation are done in such a manner that enough residue is kept on the surface of the soil until the next growing crop can provide protection.

The use of level terraces conserves moisture and helps to control erosion. This practice keeps water on the soil for a longer period, thus allowing deeper penetration.

Controlled grazing maintains adequate residue on the soils. During periods of drought, all the residue produced is needed to adequately protect the sandy soils and the strongly calcareous, sloping loamy soils from erosion.

Management of dryland soils by capability units

The use and management of dryland soils by capability unit are described in the following pages. The names of the soil series represented are given in the description of each unit, but this does not mean that all the soils of a given series are in the unit. The capability unit designation for each soil in the county is given in the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT IIe-1

The one soil in this unit, Richfield silt loam, 1 to 3 percent slopes, is a deep soil of the upland. Its surface layer is silt loam and its subsoil silty clay loam. This soil is well drained. It has moderately slow permeability, a high available water capacity, and high fertility.

This soil is suited to all crops commonly grown. Wheat and grain sorghum are the principal crops.

Water erosion and soil blowing are moderate hazards in cultivated areas. Practices that help to control erosion and conserve moisture include stubble mulching, minimum tillage, contour stripcropping, terracing, contour farming, and limited grazing of crop residue.

CAPABILITY UNIT IIc-1

This unit consists of soils of the Harney, Keith, Richfield, and Ulysses series. These deep, nearly level soils of

[2] By EARL J. BONDY, conservation agronomist, Soil Conservation Service, Salina, Kans.

Figure 16.—**Wheat stubble undercut by wide sweeps controls erosion until the next crop is planted. The soil is Harney silt loam, 0 to 1 percent slopes.**

the upland have a surface layer of silt loam and a subsoil of silty clay loam. The soils are well drained. They have moderate to moderately slow permeability, high available water capacity, and moderate to high fertility.

These soils are suited to all crops commonly grown. Wheat and sorghum are the principal crops.

Inadequate rainfall is the principal limitation. Water erosion is a negligible hazard, but blowing occurs if the soil is dry and lacks a protective cover of vegetation or residue. Practices that are effective in conserving moisture include stubble mulching, minimum tillage, and level terraces. They reduce loss of water by evaporation and allow more water to enter the soil and penetrate to a greater depth. Summer fallow and limited grazing of crop residue are also effective.

CAPABILITY UNIT IIc-2

This unit consists of soils of the Bridgeport, Grigston, and Roxbury series. These are deep, nearly level alluvial soils that occur on the floors of swales, on benches, and on terraces. All have a surface layer of silt loam. The underlying layers are silt loam, light silty clay loam, loam, or clay loam. These soils are well drained. They have moderate permeability, a high available water capacity, and moderate to high fertility.

These soils receive extra moisture as runoff from higher adjacent areas. They are suited to production of all the crops commonly grown. Wheat, sorghum, and alfalfa are the principal crops.

Inadequate rainfall is the principal limitation. Water erosion is only a slight hazard. Soil blowing occurs if the soil is dry and lacks a protective cover of growing vegetation or residue. Effective practices that help conserve moisture include stubble mulching and minimum tillage. In some places level terraces and contour farming help hold water that would otherwise run off. Other effective practices are summer fallow and limited grazing of residue.

CAPABILITY UNIT IIIe-1

This unit consists of soils of the Penden, Richfield, and Ulysses series. These are deep, gently sloping soils of the upland. They have a surface layer of silt loam or clay loam and a subsoil of clay loam or silty clay loam. These soils are well drained. The available water capacity is high, fertility is moderate to high, and permeability moderate to moderately slow.

These soils are suited to all crops commonly grown. Wheat and grain sorghum are the principal crops.

Water erosion and soil blowing are severe hazards in cultivated areas. Practices that help to control erosion and conserve moisture include stubble mulching, minimum tillage, terracing, contour farming, contour stripcropping, and limited grazing of residue.

CAPABILITY UNIT IIIe-2

Only Richfield-Ulysses silt loams, 3 to 6 percent slopes, is in this unit. These deep, sloping soils of the upland have a surface layer of silt loam and a subsoil of silty clay loam. They are well drained. The available moisture capacity is high, fertility is moderate to high, and permeability is moderate to moderately slow.

These soils are suited to all crops commonly grown. Wheat and grain sorghum are the principal crops.

Water erosion is a severe hazard in cultivated areas. Practices that help to control erosion and conserve moisture include stubble mulching, minimum tillage, terracing, contour farming, contour stripcropping, and limited grazing of residue.

CAPABILITY UNIT IIIe-3

This unit consists of soils of the Colby, Elkader, and Ulysses series. These deep, gently sloping soils of the upland have a surface layer of silt loam that is underlain by silt loam or light silty clay loam. All the soils are well drained, have moderate permeability, and have a high available water capacity. Fertility is low. The Colby and Ulysses soils are moderately eroded. Runoff is rapid, not only because of the slope, but also because the surface seals over and becomes slick during rainstorms. Erosion impairs fertility and damages plants that do not have a well-established root system.

These soils are suited to all crops commonly grown. Wheat and grain sorghum are the principal crops. Sorghum is subject to chlorosis.

Water erosion is a severe hazard in cultivated areas. Soil blowing is a severe hazard during periods of drought. Practices that help to control erosion and conserve moisture include stubble mulching, minimum tillage, terracing, contour farming, contour stripcropping, and limited grazing of crop residue.

CAPABILITY UNIT IVe-1

The one soil in this unit is Otero fine sandy loam, undulating. This deep soil of the upland has slopes of 3 to 8 percent. Its surface layer is fine sandy loam. It is underlain by fine sandy loam that is stratified with loamy sand and clay loam. This soil is well drained. It has moderately rapid permeability, a moderate available water capacity, and low fertility.

All crops that conserve the soil are suited. Sorghum and wheat are the principal cultivated crops. Much of the acreage is in grass and is used as rangeland.

Soil blowing is a very severe hazard in cultivated areas. Effective management practices in controlling erosion include maintaining continuous vegetation, stubble mulching, and minimum tillage. In most places fertilizers can be used to provide an adequate vegetative cover and thus help in controlling soil blowing. Summer fallow exposes the surface soil and increases the hazard of blowing, and grazing of crop residue decreases the amount of protective vegetation.

CAPABILITY UNIT IVe-2

This unit consists of soils of the Penden and Ulysses series. These are deep, sloping soils of the upland. They have a surface layer of clay loam or silt loam, and a subsoil of clay loam or silty clay loam. These soils are well drained. The available water capacity is high. Fertility is moderate, and permeability is moderate to moderately slow.

These soils are suited to all crops commonly grown. Sorghum is the principal crop, but wheat is also grown. Some areas are in native grass and are used as rangeland.

Water erosion and soil blowing are very severe hazards in cultivated areas. Most cultivated areas are slightly eroded. Management practices that help to control erosion and conserve moisture include stubble mulching, minimum tillage, terracing, contour farming, and contour stripcropping. Field stripcropping is an effective erosion control practice in areas where slopes are too complex for practical terrace systems. In some places fertilizers can be used to provide an adequate vegetative cover and thus help in controlling soil blowing. Grazing of crop residue decreases the amount of protective cover needed for control of erosion.

CAPABILITY UNIT IVe-3

This unit consists of soils of the Colby, Kim, Penden, and Ulysses series. These are deep, sloping, moderately eroded soils of the upland. They have a surface layer of clay loam or silt loam and a subsoil of light silty clay loam or clay loam. They have been thinned by erosion, and in some areas strongly calcareous subsoil material is exposed. Runoff is rapid, not only because of the slope but also because the surface seals over and becomes slick during rainstorms. Erosion has been moderate. Because of erosion, these soils are low in fertility. They are well drained and have moderate to moderately slow permeability and a high available water capacity.

These soils are used mainly for grain sorghum or wheat. They are also suitable for native grasses.

Water erosion is a very severe hazard in cultivated areas. Soil blowing is a very severe hazard during periods of drought.

Management practices that help control erosion and conserve moisture are stubble mulching, minimum tillage, terracing, contour farming, and contour stripcropping. Field stripcropping is beneficial in areas where slopes are too complex for practical terrace systems. Fertilizers help provide an adequate vegetative cover and thus help in controlling erosion. Grazing of crop residue decreases the amount of protective cover needed for control of erosion.

CAPABILITY UNIT IVs-1

This unit consists of soils of the Bridgeport and Church series. These are deep, nearly level soils on low

stream terraces and on low benches in the large depressions. Bridgeport soils have a surface layer of silt loam that is underlain by loam, silt loam, silty clay loam, and clay loam. They are moderately well drained to somewhat poorly drained and have moderate permeability. Church soils have a surface layer of silty clay loam that is underlain by silty clay loam, clay, and clay loam. They are somewhat poorly drained and have moderately slow permeability. Both soils have a high available water capacity and moderate to low fertility. They are slightly to moderately saline and in places are alkali. Flooding is a hazard but is infrequent.

Most of the acreage is cultivated. Wheat, sorghum, and alfalfa are the principal crops. Alfalfa can be grown in most places because the water table is high enough to furnish moisture during the dry season.

Crop production is severely affected by slight to moderate salinity and in places by alkali. The choice of crops is restricted. Depth to the water table ranges from 2 to 10 feet. Management practices include minimum tillage, stubble mulching, and planting suitable crops. Surface ponding of water on the Church soils has an adverse effect on crops. Ponding can be controlled by terracing and contour farming the higher adjacent soils.

CAPABILITY UNIT VIe-1

The one soil in this unit is Ulysses silt loam, 6 to 15 percent slopes. This deep, strongly sloping soil of the upland has a subsoil of light silty clay loam. It is well drained and has moderate permeability, a high available water capacity, and moderate fertility.

Nearly all the acreage is used for range. The hazard of water erosion generally makes this soil unsuitable for cultivation.

Proper grazing intensity, deferred grazing, and rotation grazing are among the practices that help to conserve the soil and maintain desirable grasses.

CAPABILITY UNIT VIe-2

This unit consists of soils of the Otero and Tivoli series. These deep, hummocky soils of the upland have a surface layer of loamy fine sand and fine sandy loam that is underlain by loamy fine sand, fine sand, or fine sandy loam. They are well drained to excessively drained and have moderately rapid to rapid permeability, a low to moderate available water capacity, and low fertility.

Nearly all of the acreage is used for rangeland. The severe hazard of soil blowing makes these soils generally unsuitable for cultivation.

Proper grazing intensity and deferred grazing help to conserve the soil and maintain desirable grasses. Blowouts form quickly in places that have been overgrazed. Planting and maintaining suitable grasses in these blowout areas protect adjoining areas.

CAPABILITY UNIT VIe-3

This unit consists of soils of the Colby, Kim, Penden, and Ulysses series. These are deep, strongly sloping, calcareous soils of the upland. All except Penden clay loam, 6 to 15 percent slopes, are moderately eroded. This Penden soil is slightly eroded. Penden and Kim soils are clay loam in texture in all layers of the profile. Colby and Ulysses soils have a surface layer of silt loam and a subsoil of light silty clay loam. All the soils are well drained. They have moderate and moderately slow permeability and a high available water capacity. Fertility is moderate to low. Ulysses soils have been thinned by erosion, and calcareous material is exposed. Runoff is rapid, not only because of the strong slopes but also because the surface seals over and becomes slick during rainstorms.

Because of past erosion and the continuing erosion hazard, these soils are generally not suitable for cultivated crops. Part of the acreage is cultivated, but most areas are used for rangeland.

Good management practices include planting suitable native grasses in areas that are now cultivated. Proper range use and deferred grazing protect the native grasses.

CAPABILITY UNIT VIe-4

The only mapping unit in this unit is Canlon-Campus complex. These very shallow to moderately deep soils are nearly level to steep and occupy broken slopes along deeply entrenched drainageways. They are strongly calcareous loam or clay loam throughout. Rock outcrops are common. These soils are well drained to excessively drained. Campus soils have a low available water capacity and a root zone 20 to 40 inches deep. Canlon soils have a very low available water capacity and a root zone less than 20 inches deep. Runoff is excessive in steep, shallow areas.

Most areas are used as rangeland. These soils are generally not suited to cultivated crops, because of the severe erosion hazard, the broken slopes, the shallow and moderately deep soils, the very low and low available water capacity, and the low fertility.

If the grass is overgrazed and cover is depleted, both soil blowing and water erosion occur. Except for maintaining a good cover of grass through controlled grazing, little can be done to protect these soils from erosion.

CAPABILITY UNIT VIw-1

Only Alluvial land is in this unit. It consists of deep, nearly level, calcareous soils in narrow drainageways of the upland and in areas of steep broken streambanks. The soils range from sandy loam to silty clay loam in texture. Permeability is moderate to moderately slow. The available water capacity is moderate to high. Fertility ranges from high to low.

Alluvial land is used principally for rangeland. It is generally too frequently flooded to be cultivated. In addition, areas are small and irregular, are cut by deep channels, and are generally isolated by adjacent steep, nonarable slopes.

Proper range use and deferred grazing help in maintaining desirable grasses.

CAPABILITY UNIT VIw-2

Only Ness clay is in this unit. It is a deep, nearly level clay in lagoons or potholes in the upland and on floors of large depressions. This soil is poorly drained and has a high available water capacity and very slow permeability.

In the large depression in the southwestern part of the county, these soils are calcareous throughout the profile and are high in salt and alkali. Also in this area the water table fluctuates between depths of 2 and 10 feet.

Water is ponded on the surface for several months after heavy rainfall, and crops and grasses occasionally drown. Soil blowing is a hazard in barren areas.

These soils can be used for crops, but they are usually managed like the surrounding soils in the same field. They can be protected from runoff if practices for conserving soil and water, such as terracing, contour farming, and stubble-mulch farming, are used on the adjacent soils. In most places artificial drainage is not feasible, but in some places surface drainage can be used.

CAPABILITY UNIT VIs-1

Only Drummond-Church complex is in this unit. These are deep, nearly level soils on benches and floors of large depressions. The surface layer is loam or silty clay loam. It is underlain by clay loam, sandy clay loam, silty clay loam, and clay. These soils are somewhat poorly drained and have moderately slow to slow permeability. The available water capacity is high, and fertility is moderate to low.

Salinity and alkali generally make these soils unsuitable for cultivation. The water table fluctuates between depths of 2 and 10 feet. Controlling soil blowing on alkali areas and on small sandy included areas is a problem. Water is sometimes ponded on the surface after a rainstorm, and grasses and crops drown.

Proper range use helps to maintain a stand of desirable grasses.

CAPABILITY UNIT VIIs-1

Only Minnequa-Badland complex is in this unit. This complex consists of the nearly level, gently sloping, moderately deep, calcareous Minnequa soils and the barren, rough broken areas, escarpments, and vertical-walled canyons of chalk rock and shale of the land type Badland. Minnequa soils are strongly calcareous clay loam to a depth of 20 to 40 inches. They overlie chalk rock and shale. They are well drained and have moderately slow permeability. They have a moderate available water capacity and low fertility. Badland shows little or no soil development. Fertility is low, and the root zone is restricted. Runoff is excessive; little moisture penetrates the chalk rock.

Badland supports little or no vegetation. Droughtiness and restricted root penetration limit plant growth. Consequently, the areas of Badland are best used for recreation, wildlife habitat, and esthetic purposes.

Droughtiness, a restricted root zone, and low fertility limit growth and selection of plants on the Minnequa soils of this complex. Except for maintaining a good cover of grass through control of grazing, little can be done to protect the soils from erosion.

CAPABILITY UNIT VIIs-2

Only Gravelly broken land is in this unit. It occurs on steep, broken, convex slopes. The soils are strongly calcareous sandy loam, loamy sand, sand, and gravel. They are shallow to moderately deep over basal gravel, caliche, and conglomerate sandstone. All of these materials crop out in the broken areas. The soils are well drained to excessively drained, and permeability is moderately rapid to rapid.

The very low to moderate available water capacity and very low fertility restrict the use of this land type. The shallow root zone also is a limitation. Most areas are used as range.

The vegetation consists of mid and short grasses interspersed with sand sage and yucca. Careful management of grazing is essential.

Predicted yields for dryland soils

Table 2 lists the arable soils in Lane County and gives the predicted average yields per acre of wheat and grain sorghum under high level management. Long-term records of yields in this county are not available. Yields fluctuate, mainly because of recurring drought and periods of unusually high precipitation. The predictions shown are based on information obtained from farmers, the county agent, members of the Board of Supervisors of the Soil Conservation District, and members of the Tribune and Garden City branches of the Kansas Agricultural Experiment Station.

The following practices are used to obtain the yields of wheat and grain sorghum shown in table 2.

1. Erosion is controlled and moisture is conserved by using stubble mulching, terracing, contouring, stripcropping, and summer fallow.
2. Tillage is performed at the proper time and with a suitable implement.
3. Suitable crop varieties are grown in a flexible cropping system, and seeding is done at the proper rate and date.
4. Only the crop residue not needed for protecting the soils is grazed.
5. Fertilizer is used as indicated by soil test.

TABLE 2.—*Predicted average yields per acre of dryland crops under high level management*

[Only the soils suited to cultivation are listed. Yields of wheat reflect the use of summer fallow]

Soil	Wheat	Sorghum
	Bu.	*Bu.*
Bridgeport silt loam, 0 to 1 percent slopes	24	38
Bridgeport silt loam, saline	18	26
Church silty clay loam	18	26
Elkader silt loam, 1 to 4 percent slopes	20	30
Grigston silt loam	25	40
Harney silt loam, 0 to 1 percent slopes	25	36
Harney-Richfield complex, 0 to 1 percent slopes	24	34
Keith silt loam, 0 to 1 percent slopes	26	35
Otero fine sandy loam, undulating	17	28
Pendon clay loam, 1 to 3 percent slopes	20	25
Pendon clay loam, 3 to 6 percent slopes	17	21
Pendon-Kim clay loams, 3 to 6 percent slopes, eroded	15	20
Richfield silt loam, 0 to 1 percent slopes	24	35
Richfield silt loam, 1 to 3 percent slopes	22	33
Richfield-Ulysses silt loams, 1 to 3 percent slopes	21	33
Richfield-Ulysses silt loams, 3 to 6 percent slopes	20	31
Roxbury silt loam	25	35
Ulysses silt loam, 0 to 1 percent slopes	23	34
Ulysses silt loam, 1 to 3 percent slopes	21	33
Ulysses silt loam, 3 to 6 percent slopes	18	31
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	19	31
Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded	16	29

General Management of Irrigated Soils

The supply of water for irrigation is limited in this county. According to the U.S. Census of Agriculture, in 1959 there were 5,358 acres under irrigation on 37 farms. Most of this acreage was in the northern part of the county. The Ogallala Formation is the principal source of water for irrigation. The water is pumped from deep wells. In some areas ponds are used to catch and impound water for use in irrigating soils on lower areas.

Much of the irrigation farming is done along with dryland farming. Because the farming units are large, only part of the farm is irrigated. Nearly all irrigation is by flood or furrow method.

The major management needs on irrigated soils in this county are efficient use of irrigation water, maintenance of fertility and tilth, and control of erosion.

Land leveling, contour-furrow irrigation, drop structures, pipelines, and lined ditches are sometimes needed for efficient use of irrigation water.

The use of crop residue to maintain the content of organic matter, the application of commercial fertilizers as determined by soil tests, the use of a cropping system that includes a deep-rooted legume, and the use of manure on areas cut by leveling and on all irrigated land are practices that help to maintain fertility and tilth.

Irrigated crops are grown mainly on the nearly level soils of the upland. Corn, grain sorghum, forage sorghum, and alfalfa are the principal crops.

The following factors should be considered in planning an irrigation system: (1) kind of soil, (2) quality and quantity of water, (3) control and conveyance of water, (4) type of irrigation system, (5) method of applying water, (6) preparation of the soil, and (7) adequate drainage.

Management of irrigated soils by capability units

The use and management of irrigated soils by capability units are described in the following pages. The names of the soil series represented are given in the description of each unit, but this does not mean that all the soils of a given series are in the unit. The capability unit designation for each soil in the county is given in the "Guide to Mapping Units" at the back of this survey.

IRRIGATED CAPABILITY UNIT I-1

This unit consists of deep, nearly level soils of the Bridgeport, Grigston, Harney, Keith, Richfield, Roxbury, and Ulysses series. These soils have a surface layer of silt loam and a subsoil of silt loam or silty clay loam. They are well drained and have a high available water capacity. Permeability is moderate to moderately slow, and fertility is moderate to high.

These soils are suited to all the crops grown in the area. Corn, sorghum, wheat, and alfalfa are the principal crops.

Good management provides for control of erosion, maintenance of fertility, and preservation of tilth. Effective practices include fertilization, efficient use of water, and the use of crop residue. Leveling generally is necessary for efficient application of water. Lined ditches and underground pipes help to control erosion and prevent loss of water. Improving surface drainage and controlling runoff from adjacent areas are needed in some areas.

IRRIGATED CAPABILITY UNIT IIe-1

This unit consists of deep, gently sloping soils of the Colby, Penden, Richfield, and Ulysses series. These soils have a surface of silt loam or clay loam and a subsoil of silt loam, clay loam, or silty clay loam. They are well drained and have a high available water capacity. Permeability is moderate to moderately slow, and fertility is moderate to high.

These soils are suited to all the crops commonly grown in the area. Corn, sorghum, wheat, and alfalfa are the principal crops grown under irrigation.

Good management must provide for control of erosion, maintenance of fertility, and preservation of tilth. Effective practices are fertilization, efficient use of water, and the use of crop residue. Bench leveling, contour irrigation, and sprinkler irrigation help in efficient application of water. Drop structures or underground pipes are needed in places to control erosion. In areas cut by leveling, the soils especially need additional organic matter. These additions can be obtained by plowing under crop residue and barnyard manure.

Predicted yields for irrigated soils

Table 3 gives the predicted average yields per acre of irrigated crops under high level management. Yields are not given for all soils suited to irrigation. The limited water supply in parts of the county limits to some extent the soils that can be irrigated.

The following practices are used.

1. The cropping system includes legumes, close-growing crops, and row crops.
2. Irrigation water is applied properly, and the acreage to be irrigated is determined by the water supply.
3. The irrigation system provides for uniform penetration of water and for control of erosion. Land

TABLE 3.—*Predicted average yields per acre of irrigated crops under high level management*

Soil	Grain sorghum	Corn	Wheat	Corn silage
	Bu.	*Bu.*	*Bu.*	*Tons*
Bridgeport silt loam, 0 to 1 percent slopes	120	120	55	20
Grigston silt loam	125	125	55	22
Harney silt loam, 0 to 1 percent slopes	125	125	55	22
Harney-Richfield complex, 0 to 1 percent slopes	125	125	55	22
Keith silt loam, 0 to 1 percent slopes	125	125	55	22
Penden clay loam, 1 to 3 percent slopes	100	100	45	16
Richfield silt loam, 0 to 1 percent slopes	125	125	55	22
Richfield silt loam, 1 to 3 percent slopes	115	115	45	20
Richfield-Ulysses silt loams, 1 to 3 percent slopes	110	110	45	19
Roxbury silt loam	125	125	55	22
Ulysses silt loam, 0 to 1 percent slopes	120	120	55	20
Ulysses silt loam, 1 to 3 percent slopes	105	105	45	18
Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded	100	100	45	16

leveling, contour furrowing, and the use of gated pipes and underground pipes are among the practices applied.
4. The soils are tilled at the proper time, and crop residue is returned to the soils.
5. Selected varieties of crops are planted.
6. Rate of seeding insures an optimum plant population.
7. The amount and kind of fertilizer applied provide the level of fertility needed for producing optimum yields of the particular crop.
8. Manure, if available, is used to maintain the content of organic matter.

Range Management [8]

Native grassland amounts to about 144,000 acres, or about 31 percent of the farmland in Lane County. Most of this rangeland lies along the northern edge of the county in the drainage area of the Smoky Hill River. Other large areas are concentrated along Hackberry and Walnut Creeks. Small tracts of rangeland intermingled with larger acreages of cropland occur throughout the rest of the county.

Livestock is the second largest farm enterprise in Lane County. Only the raising of wheat and sorghum for grain is more important. Livestock operations consist mostly of grazing of stockers and feeders. There are a substantial number of cowherd operations using the calves as stockers and feeders. Most ranches include acres of cropland that is used for supplemental grazing. Wheat, sudan, and sorghum stubbles are the chief crops used for temporary grazing.

The native vegetation of Lane County is primarily a mixture of mid and short grasses. The more level uplands have a cover of blue grama, buffalograss, side-oats grama, and western wheatgrass. On the rough, broken lands side-oats grama, little bluestem, blue grama, and hairy grama are the principal grasses. On the sandy soils in the southwestern part of the county, the potential plant community is mid and tall grasses, such as sand bluestem, switchgrass, little bluestem, and side-oats grama. Long periods of overgrazing have reduced the amounts of the taller grasses. Blue grama and sand dropseed now dominate many of the sandy sites.

The climate of the county, which is one of extremes, has a marked influence on the production of forage. It is characterized by great fluctuations in precipitation, temperature, humidity, and wind movement. There are often long periods of little or no rainfall during the growing season when temperature and wind movement are high and the relative humidity and available soil moisture extremely low. Precipitation received in the form of snow has little value in replenishing soil moisture on uplands and other exposed areas because most of it is swept by high winds into protected places.

Native grasses grow best from the first of May to October. Generally recurrent droughts result in some dormancy in July and August, but if enough moisture is available, the grasses start growing again around the first of September and continue to grow until the first frost. Frequently, early growth is retarded by lack of precipitation in winter and early in spring.

[8] By H. RAY BROWN, range conservationist, Soil Conservation Service.

Range sites and condition classes

A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants. A range site is the product of all environmental factors responsible for its development. In the absence of abnormal disturbance and physical site deterioration, it supports a plant community characterized by an association of species different from that of other range sites in terms of kind or proportion of species or in total annual yield. Plants on native range respond in one of three ways under grazing.

Decreasers are species in the potential plant community that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

Increasers are species in the potential plant community that increase in relative amount as the more desirable plants are reduced by close grazing. They are commonly shorter, and some are less palatable to livestock than decreasers.

Invaders are plants that cannot withstand the competition for moisture, nutrients, and light in the potential plant community. Hence, they invade and grow along with the increasers after the potential vegetation has been reduced by grazing. Many are annual weeds. Some are forbs that have some grazing value, but others have little value for grazing.

Range condition is the present state of the vegetation compared with that of the potential plant community for the site. The purpose in classifying range condition is to provide an approximate measure of any deterioration that has taken place in the plant cover and thereby provide a basis for predicting the degree of improvement possible. Four condition classes are defined. Range is in excellent condition if 76 to 100 percent of the vegetation is characteristic of the climax vegetation on the same site; it is in good condition if the percentage is between 51 to 75; in fair condition if the percentage is between 26 to 50; and in poor condition if the percentage is less than 26.

Potential forage production depends on the range site. Current forage production depends upon the range condition and the amount of moisture available to plants during the growing season.

Range kept in excellent to good condition provides optimum forage yields, and the soil is protected against excessive erosion and loss of water. Recognizing changes in the plant cover is one of the most important factors in good range management. Often the changes are misunderstood or overlooked. Growth following heavy rainfall, for example, may appear to improve the condition of the site, when actually the cover is weedy and productivity is declining. On the other hand, rangeland that has been closely grazed for short periods may have a degraded appearance that temporarily conceals its quality and ability to recover.

Descriptions of range sites

Most of the rangeland in Lane County is producing approximately one-third to one-half its potential in kinds

and amounts of forage plants. Ten range sites are recognized. They are described on the pages that follow. In each description are estimates of total herbage yields when the site is in excellent condition. Yields are given in air-dry weight, one for favorable years and one for unfavorable years.

The names of the soil series represented are mentioned in the description of each site, but this does not mean that all the soils of a given series are in the unit. The range site designation for each soil in the county can be found in the "Guide to Mapping Units."

LOAMY UPLAND RANGE SITE

This site consists of nearly level to sloping soils of the Harney, Keith, and Richfield series and nearly level to strongly sloping, uneroded soils of the Ulysses series. All are deep soils on the upland. Their surface layer is silt loam, and the subsoil silt loam or silty clay loam. Drainage is good. The available water capacity is high. Permeability is moderate to moderately slow.

Decreaser grasses, such as side-oats grama, little bluestem, and western wheatgrass, make up about 40 percent of the potential plant community. Increasers, including blue grama, buffalograss, and sand dropseed, make up approximately 60 percent of the vegetation. Western ragweed is a common forb increaser. The principal invaders are little barley, annual brome, and tumblegrass.

If this site is in excellent condition, the average annual yield of air-dry herbage is 2,200 pounds per acre in years of favorable moisture and 800 pounds per acre in years of unfavorable moisture.

LIMY UPLAND RANGE SITE

This site consists of gently sloping to strongly sloping soils of the Campus, Colby, Elkader, Kim, and Penden series and eroded soils of the Ulysses series. All of these soils are on the upland (fig. 17). The Campus soils are moderately deep and have a low available water capacity. The rest are deep and have a high available water capacity. All have a surface layer of calcareous loam, silt

***Figure 17.*—Limy Upland range site in foreground. Breaks range site in background. Penden and Campus soils are on the smoother slopes, and Canlon soils are on the more sloping and broken areas.**

loam, or clay loam and an underlying layer of calcareous loam, clay loam, or silty clay loam. Drainage is good. Permeability is moderate to moderately slow.

Decreaser grasses, such as side-oats grama, big bluestem, and little bluestem, make up about 60 percent of the potential plant community. Other perennial forbs and grasses make up the rest. The major increasers include blue grama, buffalograss, sand dropseed, and perennial three-awn. Broom snakeweed is the principal forb increaser. Common invaders are six-weeks fescue, six-weeks three-awn, windmillgrass, and tumblegrass.

If this site is in excellent condition, the average annual yield of air-dry herbage is 2,400 pounds per acre in years of favorable moisture and 800 pounds in years of unfavorable moisture.

SANDY RANGE SITE

This site consists of Otero fine sandy loam, undulating, and the Otero fine sandy loam in the mapping unit Otero soils, hummocky. These are deep, undulating or hummocky soils on the upland. They are calcareous fine sandy loam in all horizons. Drainage is good. The available water capacity is moderate. Permeability is moderately rapid.

Decreaser grasses, such as sand bluestem, little bluestem, switchgrass, sand lovegrass, and side-oats grama, make up approximately 60 percent of the potential plant community. Other perennial grasses, forbs, and woody plants make up the rest. The dominant increaser grasses are blue grama, sand dropseed, buffalograss, sand paspalum, and perennial three-awn. Sand sagebrush and small soapweed are the dominant woody increasers. Common invaders are windmillgrass, tumblegrass, six-weeks fescue, and curlycup gumweed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 2,200 pounds per acre in years of favorable moisture and 1,200 pounds per acre in years of unfavorable moisture.

SANDS RANGE SITE

This range site consists of Tivoli loamy fine sand and the Otero loamy fine sand in the mapping unit Otero soils, hummocky. These are deep, hummocky soils on the upland. Their surface layer is loamy fine sand, and the underlying layer fine sand, loamy fine sand, or fine sandy loam. Drainage is good to excessive. The available water capacity is low. Permeability is rapid.

Decreaser grasses, such as sand bluestem, little bluestem, switchgrass, sand lovegrass, and big sandreed, make up to 70 percent of the potential plant community. Other perennial grasses, forbs, and woody plants make up the rest. The dominant increaser grasses are blue grama, sand dropseed, and sand paspalum. Sand sagebrush is a common woody increaser. Invaders, such as false buffalograss, purple sandgrass, sandbur, and red lovegrass, are common if the site is overgrazed.

If this site is in excellent condition, the average annual yield of air-dry herbage is 2,500 pounds per acre in years of favorable moisture and 1,500 pounds per acre in years of unfavorable moisture.

LOAMY LOWLAND RANGE SITE

Alluvial land, the only mapping unit in this range site, is on the narrow flood plains of drainageways. The soils are deep, nearly level sandy loams to silty clay loams. They receive water from flooding but are well drained. The available water capacity is high. Permeability is moderate.

Decreaser grasses (fig. 18), including switchgrass, big bluestem, little bluestem, side-oats grama, and Canada wildrye, make up approximately 70 percent of the potential plant composition. Other perennial forbs and grasses make up the rest. The important increaser grasses are western wheatgrass, blue grama, and buffalograss. Annual grasses are the principal invaders.

If this site is in excellent condition, the average annual yield of air-dry herbage is 4,000 pounds per acre in years of favorable moisture and 2,000 pounds per acre in years of unfavorable moisture.

LOAMY TERRACE RANGE SITE

This range site consists of nearly level soils of the Bridgeport, Grigston, and Roxbury series. These soils are on flood plains and terraces. They receive runoff from adjacent soils on the upland and water from stream flooding. They have a surface layer of silt loam and an underlying layer of loam, silt loam, clay loam, or silty clay loam. Drainage is good. The available water capacity is high. Permeability is moderate.

Decreaser grasses, such as switchgrass, big bluestem, little bluestem, side-oats grama, and Canada wildrye, make up around 60 percent of the potential plant community. Other perennial forbs and grasses make up the rest. The dominant increaser grasses are western wheatgrass, blue grama, and buffalograss. The principal invaders are silver bluestem, annual brome, little barley, windmillgrass, and tumblegrass.

If this site is in excellent condition, the average annual yield of air-dry herbage is 3,000 pounds per acre in years of favorable moisture and 1,500 pounds per acre in years of unfavorable moisture.

GRAVELLY HILLS RANGE SITE

Gravelly broken land, the only mapping unit in this range site, has steep, broken slopes and is on the upland. The soils are shallow to moderately deep over basal gravel, caliche, or conglomerate sandstone. They are strongly calcareous sandy loam, loamy sand, sand, or gravel. Drainage is good to excessive. The available water capacity is moderate to very low. Permeability is moderately rapid to rapid.

In the potential plant community decreaser grasses, such as sand bluestem, little bluestem, switchgrass, and side-oats grama, make up to 60 percent of the total plant composition. Other perennial forbs and grasses make up the rest. Increaser grasses, consisting of blue grama, hairy grama, sand dropseed, and buffalograss, make up to 40 percent of the potential. The principal woody plant increasers are sand sagebrush and small soapweed (fig. 19). Common invaders are tumblegrass, windmillgrass, and annual three-awn.

If this site is in excellent condition, the average annual yield of air-dry herbage is 1,800 pounds per acre

Figure 18.—**Loamy Lowland range site in excellent condition.**

in years of favorable moisture and 800 pounds per acre in years of unfavorable moisture.

SALINE LOWLAND RANGE SITE

This range site consists of soils of the Bridgeport, Church, and Drummond series. These are deep, nearly level, saline and alkali soils on benches, floors of large depressions, and terraces of streams. They have a surface layer of silt loam, loam, and silty clay loam. The underlying material ranges from sandy clay loam to light clay in texture. Drainage is moderately good to somewhat poor. The water table fluctuates to within reach of grass roots. The available water capacity is high. Permeability is moderate to slow.

Decreaser grasses, such as switchgrass, alkali sacaton, and western wheatgrass, make up approximately 75 percent of the potential plant community. Other perennial grasses and forbs make up the rest. The principal increasers are inland saltgrass, blue grama, buffalograss, and western ragweed. Common invaders are kochia, little barley, and annual brome.

If this site is in excellent condition, the average annual yield of air-dry herbage is 3,500 pounds per acre in years of favorable moisture and 1,500 pounds per acre in years of unfavorable moisture.

CHALK FLATS RANGE SITE

The Minnequa soil in the Minnequa-Badland complex, the only soil in this range site, is a nearly level to gently sloping soil on the upland. It is moderately deep over chalk. It ranges from loam to silty clay loam in texture and is strongly calcareous. Drainage is good. The available water capacity is moderate. Permeability is moderately slow.

The potential plant community is a mixture of such decreaser grasses as side-oats grama, western wheatgrass, little bluestem, big bluestem, and switchgrass. These grasses make up about 70 percent of the total plant cover.

Figure 19.—**Gravelly Hills range site.**

Other perennial grasses and forbs make up the rest. The important increasers are buffalograss, blue grama, inland saltgrass, sand dropseed, and perennial three-awn. Increaser forbs are racemed milkvetch, narrowleaf milkvetch, desert princesplume, and broom snakeweed. The principal invaders are tumblegrass, windmillgrass, little barley, and annual three-awn.

If this site is in excellent condition the average annual yield of air-dry herbage is 3,000 pounds per acre in years of favorable moisture and 1,500 pounds per acre in years of unfavorable moisture.

BREAKS RANGE SITE

The Canlon soil in the Canlon-Campus complex, the only soil in this range site, is a gently sloping to steep soil on the upland. It is loam in texture, is strongly calcareous, and is very shallow over caliche. Drainage is good to excessive. The available water capacity is very low. Permeability is moderate.

In the potential plant community decreaser grasses, such as little bluestem, side-oats grama, big bluestem, and switchgrass, make up at least 60 percent of the total plant composition. Other perennial grasses and forbs make up the rest. Increaser plants, such as blue grama, hairy grama, buffalograss, sand dropseed, purple three-awn, and broom snakeweed, make up to 40 percent of the potential composition. Common invaders are ring muhly, tumblegrass, and annual three-awn.

If this site is in excellent condition, the average annal yield of air-dry herbage is 1,750 pounds per acre in years of favorable moisture and 700 pounds per acre in years of unfavorable moisture.

Range use

Proper range use and a system for deferring grazing improve the condition of the range, cost little to use, and are needed on all rangeland, regardless of other practices.

Proper use of the range, that is, making seasonal adjustments in the number of livestock to make best use of the available forage, maintains the carbohydrate reserve and the vigor of the plant cover, maintains the most desirable vegetation, and improves the composition of vegetation that has deteriorated. This practice applies to native range used for winter grazing, for summer grazing, or for year-long grazing.

Deferring grazing for a prescribed period during any growth period promotes natural revegetation by increasing the vigor of the stand and by permitting desirable

plants to produce seed in favorable years. It also provides a feed reserve for fall and winter grazing. In addition to being an important practice for improving range, deferred grazing is a means of building up a reserve of range forage for emergency use.

Other practices that improve the range and help to control the movement of livestock are fencing to separate ranges, changing of salting grounds, distribution of watering areas, controlling weeds and brush, and reseeding deteriorated areas with desirable species

Windbreaks

Tree plantings in Lane County have been limited to farmstead windbreaks and trees grown for shade or ornament. There is no significant native forest or woodland. The soils on flood plains along the main drainageways support a sparse, mixed stand of cottonwood, elm, and other trees and shrubs. Trees and shrubs survive only if they receive extra moisture.

Windbreaks protect farmsteads and feeding areas for livestock. They can be established successfully if they are well planned and well cared for (fig. 20).

Most windbreaks in Lane County receive extra moisture during the first 2 to 4 years. Water is hauled, irrigated from wells, or diverted from adjacent areas.

The soils suitable for growing trees for windbreaks have been placed in three windbreak suitability groups—Silty Upland, Sandy Upland, and Lowland. Each group consists of soils that are similar in potential for tree growth and in management requirements.

The Silty Upland group consists of nearly level to strongly sloping soils of the Colby, Elkader, Harney, Keith, Kim, Penden, Richfield, and Ulysses series. These soils are deep. They have a surface layer of silt loam or clay loam. They have moderate to moderately slow permeability, are well drained, and have a high available water capacity.

The Sandy Upland group consists of undulating and hummocky soils of the Otero and Tivoli series. These soils are deep. They have a surface layer of fine sandy loam or loamy fine sand. They have moderately rapid to rapid permeability, are well drained to excessively drained, and have a moderate to low available water capacity.

The Lowland group consists of nearly level soils of the Bridgeport, Grigston, and Roxbury series and of

Figure 20.—**Farmstead windbreak on Harney silt loam, 0 to 1 percent slopes.**

Alluvial land. These are deep, well-drained soils on flood plains and low terraces. They have a surface layer of loam to silty clay loam. Permeability is moderate. The available water capacity is high.

Gravelly broken land, the soils of the Canlon-Campus complex, and Minnequa-Badland complex are not well suited to trees because they are shallow to moderately deep, have rock outcrops, and are steep in some areas. Ness clay is not suited because it is ponded after heavy rains and droughty during dry periods. Church and Drummond soils and Bridgeport silt loam, saline, are saline and alkali and have a fluctuating water table. These soils are best suited to species that are not affected by salt and alkali. Church and Drummond also are ponded during periods of heavy rainfall. Tree growth in a windbreak is likely to vary because of the variation in saline and alkali conditions within short distances.

Table 4 lists the trees and shrubs suitable for windbreaks and gives the estimated height in 10 years on dryland and irrigated soils.

Drought-resistant species suitable for windbreaks are eastern redcedar, Siberian elm (Chinese elm), Osage-orange, Rocky Mountain juniper, and ponderosa pine. Hardwoods in windbreaks on dryland soils should be effective for 25 to 35 years on upland sites and for 40 to 60 years on lowland sites. Conifers on dryland soils should be effective for 50 years on upland sites and for 80 years on lowland sites. In Lane County, conifers should make up at least 50 percent of a windbreak.

Planting stock, especially conifers, should be properly handled to prevent the trees from drying out from exposure to air and heat. The survival percentage of potted pines and cedars is greater than for bare rooted planting stock. Seedlings that withstand the severe climate should be used. Tree plantings need protection from fires, livestock, insects, rabbits, and diseased plants. More water will be available for tree growth if the windbreak is kept free of weeds and grass. Since rabbits are especially fond of young trees and shrubs, plantings may need protection continually until they are 5 years old or even older.

Fish and Wildlife Resources[4]

The fish and wildlife resources in Lane County are closely associated with sites suitable for recreational development. The only soils that have severe limitations as recreational sites are those subject to flooding or ponding. Hunters are attracted to the county by the large number of ring-necked pheasants. Other hunting opportunities include doves, quail, waterfowl, coyotes, and rabbits.

Pheasants are most numerous on association 2. This association makes up approximately 25 percent of the county. Irrigation from deep wells in this association is increasing, especially on the nearly level soils, and irrigated cropland attracts pheasants.

Bobwhite quail occur in choice locations generally along and adjacent to the Roxbury and Bridgeport soils within association 2. These birds are also established near farmstead windbreaks adjacent to cropland on association 1.

Deer are increasing in number. Lane County is within the transition zone of both species of deer reported within the State. Mule deer are predominate, but there are a few whitetails. Association 3 supports habitat for the resident deer population. It has good potential for antelope.

Fishing waters are scarce. The North and South Forks of Walnut Creek provide some fishing, mainly for channel catfish. The possibility of deepening and confining several large shallow bodies of water should be considered to help reduce evaporation and maintain fish populations. There are sites suitable for pond construction on associations 2 and 3 (fig. 21). Fishing opportunities may also be developed in ponds constructed to retain excess water from irrigated fields. During periods of drought, supplemental water from the well may be needed to maintain the fishery.

During their semi-annual migrations through the county, waterfowl utilize the water that is ponded in the depressions occupied by Ness clay. The depressions are mainly in association 1.

[4] By JACK W. WALSTROM, biologist, Soil Conservation Service.

TABLE 4.—*Trees and shrubs suitable for windbreaks and estimated height attained in 10 years*

Suitable trees and shrubs	Windbreak groups					
	Silty Upland		Sandy Upland		Lowland	
	Dryland	Irrigated	Dryland	Irrigated	Dryland	Irrigated
	Feet	*Feet*	*Feet*	*Feet*	*Feet*	*Feet*
Tamarisk	11	20	11	15	13	20
Russian-olive	13	22	14	22	16	22
Osage-orange	13	22	14	22	16	22
Mulberry	15	20	18	24	19	24
Siberian elm	24	32	26	35	26	32
Honeylocust	20	27	21	28	21	28
Eastern redcedar	9	11	10	12	11	12
Rocky Mountain juniper	9	11	10	12	11	12
Ponderosa pine	9	11	10	12	11	12
Aromatic sumac	8	11	8	11	10	11

Figure 21.—**Pond on association 3 used for watering livestock and for fishing and other recreational uses.**

Mourning doves, a game species in Kansas, utilize seeds of various weeds and crops. Hunters harvest the surplus population during hunting season.

Skunks (both spotted and striped), racoon, muskrat, beaver, badger, spotted and 13-line ground squirrel, eastern and desert cottontail, blacktailed jackrabbit, and fox squirrel are other species of wildlife resident within the county.

Table 5 shows the potential of the soil associations in the county to provide habitat needed by wildlife.

Openland wildlife normally inhabits croplands, pastures, meadows and odd areas of herbaceous vegetation. Pheasant, quail, cottontails, badger, coyote, and meadow larks are examples.

Woodland wildlife normally inhabits wooded or partially wooded areas. Deer, racoon, squirrel, and thrushes are examples.

Wetland wildlife normally inhabits areas such as ponds, marshes, rivers, streams and swamps. Ducks, shore birds, beaver, mink, and muskrat are examples.

Technical assistance in the planning and application of wildlife developments can be obtained from the Soil Conservation Service in Dighton, Kans. Additional information and assistance can be obtained from the Kansas Forestry Fish and Game Commission, the Bureau of Sport Fisheries and Wildlife, and the Federal Extension Service.

Use of the Soils in Engineering [5]

Some soil properties are of special interest to engineers because they affect the design, construction, and maintenance of roads, airports, pipelines, building foun-

[5] Prepared by CARL L. ANDERSON, civil engineer, and KENNETH H. SALLEE, soil scientist, Soil Conservation Service.

TABLE 5.—*Potential of soil associations for providing wildlife habitat*

Soil association	Kinds of wildlife	Potential for producing kinds of habitat			
		Woody	Herbaceous	Food	Aquatic
Association 1	Openland	Good	Good	Good	
	Woodland	Good	Good	Good	
	Wetland			Fair	Fair.
	Fish				Good.
Association 2	Openland	Fair	Good	Good	Fair.
	Woodland	Fair	Good	Fair	
	Fish				Fair.
Association 3	Openland	Fair	Good	Fair	
	Woodland	Poor	Good	Fair	
Association 4	Openland	Fair	Fair	Good	
	Wetland			Fair	Fair.
	Fish				Good.
Association 5	Openland	Poor	Good	Good	

dations, facilities for water storage, erosion control structure, drainage systems, and sewage disposal systems. Among the properties most important to the engineer are permeability to water, shear strength, compaction characteristics, texture, plasticity, and pH. Topography, the depth to unconsolidated material, and the depth to the water table also are important.

The information in this survey can be used to—

1. Make studies that will aid in selecting and developing sites for industrial, business, residential, and recreational uses.
2. Make preliminary estimates of the engineering properties of soils in planning agricultural drainage systems, farm ponds, terraces, waterways, dikes, diversions, irrigation canals, and irrigation systems.
3. Make preliminary evaluations that will aid in selecting locations for highways and airports, pipelines, and other engineering structures, and in planning detailed investigation at the selected locations.
4. Locate probable sources of gravel, sand, and other construction material.
5. Correlate performance with soil mapping units to develop information that will be useful in planning engineering practices and in designing and maintaining engineering structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement other publications, such as maps, reports, and aerial photographs, that are used in preparation of engineering reports for a specific area.
8. Develop other preliminary estimates for construction purposes pertinent to a particular area.

With the soil map for identification of soil areas, the engineering interpretations reported in tables 6, 7, and 8 can be useful for many purposes. It should be emphasized, however, that the interpretations reported here do not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and excavations deeper than the depth of layers here reported.

Some of the terms used by soil scientists have a special meaning in soil science that may not be familiar to engineers. These terms are defined in the Glossary. Additional information about the soils can be found in the sections "Descriptions of the Soils" and "Formation and Classification of the Soils."

Engineering classification systems

The two systems most commonly used in classifying soils for engineering are the systems developed by the American Association of State Highway Officials (AASHO) (*1*) and the Unified system (*19*). Both systems are explained in the PCA Soil Primer (*12*).

The AASHO system is used to classify soils according to those properties that affect use in highway construction. In this system all soil material is classified in seven principal groups. The groups range from A–1, which consists of soils that have the highest bearing strength and are the best soils for subgrade, to A–7, which consists of soils that have the lowest strength when wet. Within each group, the relative engineering value of the soil material is indicated by a group index number. The numbers range from 0, for the best material, to 20, for the poorest. The group index number is shown in parentheses following the soil group symbol (see table 6).

In the AASHO system, the soil material may be further divided into the following two major groups: (1) granular material in which 35 percent or less of the material passes a 200-mesh sieve, and (2) silt-clay material in which more than 35 percent of the material passes a 200-mesh sieve. The silty part of the silt-clay material has a plasticity index of 10 or less, and the clayey material a plasticity index greater than 10. The plasticity index is the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed as a percentage of the ovendry weight of the soil at which the material passes from a plastic to a liquid

TABLE 6.—*Engineering*

[Tests performed by the State Highway Commission of Kansas under a cooperative agreement with the Bureau of Public Roads

Soil name and location	Parent material	Kansas report no. S-64–	Depth	Moisture-density data [1]		Mechanical analysis [2]				
						Percentage passing sieve—				
				Maximum dry density	Optimum moisture	2-in.	1½-in.	1-in.	¾-in.	⅜-in.
			In.	*Lb./cu.ft.*	*Pct.*					
Canlon loam: 800 feet N. and 360 feet E. of SW. corner sec. 2, T. 18 S., R. 29 W. (Modal)	Calcareous old alluvium.	51–24–1	0–5	108	16	------	------	------	------	------
		51–24–2	10–60	------	------	100	95	86	74	54
Penden clay loam: 780 feet E. and 80 feet N. of SW. corner sec. 16, T. 17 S., R. 27 W. (Modal)	Clay loam old alluvium.	51–22–1	0–9	98	19	------	------	------	------	------
		51–22–2	15–34	107	18	------	------	------	------	------
		51–22–3	34–64	107	19	------	------	------	------	------
Richfield silt loam: 1,620 feet W. and 50 feet S. of NE. corner sec. 1, T. 20 S., R. 28 W. (Modal)	Loess.	51–27–1	0–5	104	18	------	------	------	------	------
		51–27–2	9–17	95	24	------	------	------	------	------
		51–27–3	26–51	97	22	------	------	------	------	------
		51–27–4	51–64	96	23	------	------	------	------	------

[1] Based on AASHO Designation: T 99–57, Method A (*1*), with the following variations: (1) all material is ovendried at 230° F. and crushed in a laboratory crusher, and (2) no time is allowed for dispersion of moisture after mixing with the soil material.

[2] Mechanical analysis according to AASHO Designation: T 88–57 (*1*) with the following variations: (1) all material is ovendried at 230° F. and crushed in a laboratory crusher, (2) the sample is not soaked prior to dispersion, (3) sodium silicate is used as the dispersing agent, and (4) dispersing time, in minutes, is established by dividing the plasticity index value by 2; the maximum time is 15 minutes, and the minimum time is 1 minute. Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method, and the various grain-

state. The plastic limit is the moisture content, expressed as a percentage of the ovendry weight of the soil, at which the material passes from a semisolid to a plastic state.

In the Unified system (*19*) the soils are identified according to particle-size distribution, plasticity, and liquid limit. The soil material is identified as coarse grained, that is, gravel (G) and sand (S); fine grained, silt (M) and clay (C); and highly organic (Pt.). There are no highly organic soils in Lane County.

Under the Unified system clean sands are identified by the symbols SW or SP; sands that have fines of silt and clay, by SM and SC; silts and clays that have a low liquid limit, by ML and CL; and silts and clays that have a high liquid limit, by MH and CH.

Soil scientists use the USDA textural classification (*16*). In this system, the texture of the soil is determined according to the proportion of soil particles smaller than 2 millimeters in diameter, that is, the proportion of sand, silt, and clay. Textural modifiers, such as gravelly, stony, shaly, and cobbly, are used as needed.

Engineering properties and interpretations

Table 6 presents data obtained by laboratory tests on soil samples taken from selected soil profiles.

Table 7 gives estimates of particle-size distribution and of the following soil properties that affect engineering work: permeability, available water capacity, and shrink-swell potential. The estimates are based on data shown in table 6, on tests performed at construction sites by the Kansas State Highway Department, on experience with the same kinds of soil in other counties, and on the information in other sections of this survey. Some of the terms for which data are shown are explained in the following paragraphs. A complete description of a profile typical of each series is given in the section "Descriptions of the Soils."

The particle-size distribution shown under "Percentage passing sieve" is based on tests made by the combined sieve and hydrometer methods. It shows the percentages of material that pass through the openings of sieves of various sizes. Coarse-grained material is retained on the No. 200 sieve.

Soil permeability is the quality that enables the soil to transmit water and air. It is measured in terms of the rate at which water passes through an undisturbed soil.

Available water capacity is the capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

Shrink-swell potential is an indication of the volume change to be expected of soil material with changes in water content. It is an important factor in planning roads and other engineering structures. Ness soils, for example, have a high shrink-swell potential. They shrink greatly when dry and swell when wet. Otero and Tivoli soils, for example, have a low shrink-swell potential.

In Lane County only four soils are affected by salt and alkali. They are Church silty clay loam, Drummond-Church complex, Bridgeport silt loam, saline, and the Ness clay that occurs in the depression in the southwest

test data

(BPR) in accordance with standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis[2]—Continued								Liquid limit	Plasticity index	Classification	
Percentage passing sieve—Continued				Percentage smaller than—							
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.			AASHO	Unified[3]
								Pct.			
---------	100	96	70	46	27	11	8	31	10	A-4 (7)	ML-CL
42	32	27	8	--------	--------	--------	--------	47	11	([4])	
---------	100	99	94	74	41	28	22	44	23	A-7-6 (14)	CL
---------	100	100	93	70	47	26	22	36	20	A-6 (12)	CL
---------	100	100	89	76	53	32	28	40	25	A-6 (14)	CL
---------	100	99	98	80	42	18	12	32	10	A-4 (8)	ML-CL
---------	100	100	100	86	58	37	32	54	34	A-7-6 (19)	CH
---------	100	100	100	90	62	39	29	45	21	A-7-6 (13)	CL
---------	100	100	100	84	56	30	23	40	17	A-6 (11)	CL

size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analysis data used in this table are not suitable for naming textural classes for soils.

[3] SCS and BPR have agreed to consider that all soils having plasticity indexes within two points of A-line are to be given a borderline classification. An example of borderline classification obtained by this use is ML-CL.

[4] Caliche.

corner of the county. A few small areas of Alluvial land are slightly to moderately affected by salt and alkali.

Dispersion is likely in small areas of slickspots on Church silty clay loam; in the subsurface layers of Drummond-Church complex and Bridgeport silt loam, saline; and in all layers of the Ness clay that is in the large depression in the southwest corner of the county.

Reaction of the soils in the county ranges from neutral to moderately alkaline.

The depth to bedrock and to consolidated calcareous (caliche) deposits varies according to differences in position and topography of the soils. Bedrock occurs at a depth of 8 to 20 inches in Canlon soils, 20 to 40 inches in Campus soils, and 24 to 60 inches in Minnequa soils. The Canlon-Campus complex and the areas of Gravelly broken land are good sources of material for road surfacing. Extensive outcrops of chalk and shale occur in the Minnequa-Badland complex. There are only a few outcrops in the Canlon-Campus complex. The depth to bedrock is more than 60 inches in all other soils in the county.

The Church, Drummond, and Ness soils in the large depression in the southwest corner of the county have a fluctuating water table at a depth of 2 to 10 feet. In Bridgeport silt loam, saline, the water table fluctuates between 2 and 10 feet. In Grigston silt loam, Bridgeport silt loam, 0 to 1 percent slopes, and Roxbury silt loam, the water table is normally 6 feet below the surface. Ground water is many feet below the surface for all other soils in the county. For additional information about the depth to bedrock and ground water, refer to "Geology and Ground-Water Resources of Lane County, Kansas," a publication of the University of Kansas (*13*).

Table 8 shows specific features of the soils that affect their use for various engineering purposes. The first part of this table rates the soils according to the suitability of the material as a source of topsoil, sand, and gravel, road subgrade, and road fill. The middle part shows soil features that affect use of the soils for highway location and engineering structures. The last part shows the degree and kinds of limitations that affect use of the soils for sewage disposal.

Topsoil is needed to establish vegetation for erosion control on embankments, on the shoulders of roads, in ditches, and on cut slopes. Each layer of the soil was considered as a possible source of topsoil, though only one estimate is shown in the table. The surface layer and underlying layers may have different ratings because of differences in texture or other characteristics. Normally, the cut slopes on the deep loamy soils can be seeded without adding a layer of topsoil. Generally an addition of topsoil is needed in cut areas on the moderately deep and very shallow soils and on sandy soils.

Roads that cross soils subject to ponding during wet periods must either be constructed on embankments or be provided with a good system of underdrains and surface drains. Ness soils are subject to ponding, and Church and Drummond soils are subject to flooding. These soils have moderately slow to very slow permeability and poor surface drainage.

TABLE 7.—*Estimated*

[The properties of Alluvial land, Gravelly broken land, and the Badland

Soil series and map symbols	Depth from surface	Classification: USDA texture	Classification: Unified	Classification: AASHO
	In.			
Bridgeport: Be, Bg.	0–11	Silt loam	ML–CL	A–4 or A–6
	11–28	Clay loam	CL	A–6 or A–7
	28–60	Loam	ML–CL	A–4 or A–7
Campus. Mapped only with Canlon soils.	0–30	Loam	CL	A–6
	30	Caliche.		
Canlon: Cc. For Campus part of unit Cc, refer to Campus series.	0–10	Loam	ML or CL	A–4 or A–6
	10	Caliche.		
Church: Ch.	0–26	Silty clay loam	CL	A–7
	26–34	Clay	CH	A–7
	34–60	Clay loam	CL	A–6 or A–7
Colby. Mapped only with Ulysses soils.	0–60	Silt loam and light silty clay loam	ML–CL or CL	A–4 or A–6
Drummond: Dc. For Church part of unit Dc, refer to Church series.	0–4	Loam	ML–CL	A–4 or A–6
	4–13	Clay loam and silty clay loam	CL	A–7
	13–20	Sandy clay loam	SC	A–6
	20–35	Silty clay loam	CL	A–7
	35–54	Sandy clay loam	SC	A–6
	54–60	Silty clay loam	CL	A–7
Elkader: Ek.	0–9	Silt loam	ML	A–4
	9–60	Silty clay loam	ML–CL	A–7
Grigston: Gs.	0–48	Silt loam	ML–CL	A–4
	48–60	Silty clay loam	ML–CL	A–7
Harney: Ha, Hr. For Richfield part of unit Hr, refer to Richfield series.	0–10	Silt loam	ML–CL	A–4 or A–6
	10–14	Light silty clay loam	CL	A–7
	14–26	Silty clay loam	CH or CL	A–7
	26–60	Light silty clay loam	CL	A–7
Keith: Ka.	0–11	Silt loam	ML–CL	A–4 or A–6
	11–25	Silty clay loam	CL	A–7
	25–60	Silt loam	ML–CL	A–4 or A–6
Kim: Km. For Penden part of unit Km, refer to Penden series.	0–60	Clay loam	CL	A–6
Minnequa: Mb.	0–31	Clay loam	CL	A–7 or A–6
	31	Chalk.		
Ness: Ne.	0–50	Clay, silty clay, and heavy silty clay loam.	CH	A–7
	50–60	Silty clay loam	CL	A–7
Otero:				
Of.	0–60	Fine sandy loam	SM	A–2–4 or A–4
Oh.	0–20	Loamy fine sand	SM	A–2
	20–46	Fine sandy loam	SM	A–2–4 or A–4
	46–60	Loamy fine sand	SM	A–2
Penden: Pe, Pf, Ph, Pk. For Kim part of unit Pk, refer to Kim series.	0–9	Clay loam	CL	A–7–6 or A–6
	9–60	Clay loam	CL	A–6

properties

part of Minnequa-Badland complex are too variable to be estimated]

Percentage passing sieve—				Permeability	Available water capacity	Shrink-swell potential
No. 4	No. 10	No. 40	No. 200			
				In./hr.	*In./in. of soil*	
100	95–100	90–100	80–90	0. 63–2. 00	0. 14–0. 18	Moderate.
100	95–100	90–100	70–80	0. 63–2. 00	0. 15–0. 19	Moderate.
100	95–100	85–95	65–75	0. 63–2. 00	0. 12–0. 16	Low.
95–100	95–100	90–100	65–80	0. 63–2. 00	0. 15–0. 19	Moderate.
100	100	85–100	65–75	0. 63–2. 00	0. 12–0. 16	Low to moderate.
100	100	95–100	90–100	0. 20–0. 63	0. 14–0. 18	Moderate to high.
100	100	90–100	90–100	0. 06–0. 20	0. 14–0. 18	High.
100	100	90–100	65–80	0. 20–0. 63	0. 14–0. 18	Moderate to high.
100	100	90–100	80–95	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	85–95	60–75	0. 63–2. 00	0. 12–0. 16	Low to moderate.
100	100	90–100	90–95	0. 06–0. 20	0. 14–0. 18	Moderate to high.
100	95–100	80–90	40–50	0. 20–0. 63	0. 12–0. 16	Low to moderate.
100	100	95–100	90–95	0. 06–0. 20	0. 14–0. 18	High.
100	95–100	80–90	40–50	0. 20–0. 63	0. 12–0. 16	Low to moderate.
100	100	95–100	90–95	0. 06–0. 20	0. 14–0. 18	Moderate to high.
100	100	90–100	85–95	0. 63–2. 00	0. 14–0. 18	Low.
100	100	95–100	80–90	0. 63–2. 00	0. 14–0. 18	Low to moderate.
100	95–100	90–100	85–95	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	95–100	85–95	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	90–100	75–95	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	95–100	90–100	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	95–100	90–100	0. 20–0. 63	0. 14–0. 18	Moderate to high.
100	100	95–100	90–100	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	90–100	85–95	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	95–100	90–100	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	90–100	85–95	0. 63–2. 00	0. 14–0. 18	Moderate.
95–100	95–100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	Moderate to high.
100	95–100	90–100	70–80	0. 20–0. 63	0. 15–0. 19	Low to moderate.
100	100	95–100	85–100	<0. 06	0. 14–0. 18	High.
100	100	95–100	90–100	0. 20–0. 63	0. 14–0. 18	Moderate to high.
100	95–100	75–85	30–45	2. 00–6. 30	0. 09–0. 13	Low.
100	100	90–95	15–25	6. 30–10. 00	0. 06–0. 09	Low.
100	95–100	75–85	30–45	2. 00–6. 30	0. 09–0. 13	Low.
100	100	90–95	15–25	6. 30–10. 00	0. 06–0. 09	Low.
100	100	90–100	85–95	0. 20–0. 63	0. 15–0. 19	Moderate to high.
100	100	90–100	85–95	0. 20–0. 63	0. 15–0. 19	Moderate to high.

TABLE 7.—*Estimated*

Soil series and map symbols	Depth from surface	Classification: USDA texture	Unified	AASHO
	In.			
Richfield: Rm, Rn, Ro, Rp. For Ulysses part of units Ro and Rp, refer to Ulysses series.	0–5	Silt loam	ML-CL	A–4
	5–26	Silty clay loam	CH or CL	A–7–6
	26–60	Light silty clay loam	CL	A–7–6 or A–6
Roxbury: Rx.	0–31	Silt loam	ML-CL	A–4 or A–6
	31–52	Light silty clay loam	CL	A–6 or A–7
	52–60	Loam	ML-CL	A–4 or A–6
Tivoli: Ts.	0–11	Loamy fine sand	SM	A–2
	11–60	Fine sand	SP-SM	A–3
Ulysses: Ua, Ub, Uc, Ud, Ue, Um, Un.	0–6	Silt loam	ML-CL	A–6
	6–11	Silty clay loam	ML-CL	A–6
For Colby part of units Ue, Um, and Un, refer to Colby series.	11–60	Silt loam	ML-CL	A–6

TABLE 8.—*Engineering*

[C. W. HECKATHORN, field soils engineer, and HERBERT E. WORLEY, soils research engineer, Kansas State Highway Commission, No interpretations are given for Alluvial land, Gravelly broken land, and the Badland

Soil series and map symbol	Suitability as source of—: Topsoil	Sand and gravel	Road subgrade	Road fill	Soil features affecting—: Highway location	Dikes and levees
Bridgeport: Be	Good	Not suitable	Fair	Good	Infrequent flooding.	Fair stability; moderate permeability.
Bg	Poor: salinity.	Not suitable	Fair	Good	Infrequent flooding; fluctuating water table.	Fair stability; moderate permeability.
Campus. Mapped only with Canlon soils.	Fair above substratum; poor in substratum.	Poor	Poor	Good	Moderate plasticity; high compressibility.	Moderate shrink-swell potential; moderate permeability.
Canlon: Cc. For Campus part of unit Cc, refer to Campus series.	Fair above substratum; poor in substratum.	Poor for sand; poor for gravel but good in local pockets.	Poor	Good	Good drainage	([1])

See footnote at end of table.

properties—Continued

Percentage passing sieve—				Permeability	Available water capacity	Shrink-swell potential
No. 4	No. 10	No. 40	No. 200			
				In./hr.	*In./in. of soil*	
100	100	95–100	90–100	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	95–100	95–100	0. 20–0. 63	0. 14–0. 18	Moderate to high.
100	100	95–100	95–100	0. 63–2. 00	0. 14–0. 18	Moderate.
100	95–100	90–100	75–85	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	95–100	85–95	0. 63–2. 00	0. 14–0. 18	Moderate.
100	95-100	85 95	60-75	0. 63–2. 00	0. 12–0. 16	Moderate.
100	100	90–95	15–25	6. 30–10. 00	0. 06–0. 09	Low.
100	100	65–85	5–15	6. 30–10. 00	0. 06–0. 09	Low.
100	100	90–100	80–95	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	95–100	85–100	0. 63–2. 00	0. 14–0. 18	Moderate.
100	100	90–100	80–95	0. 63–2. 00	0. 14–0. 18	Moderate.

interpretations

helped prepare columns headed "Road subgrade" and "Road fill," under a cooperative agreement with the Bureau of Public Roads. part of Minnequa-Badland complex because the soil material in these land types is too variable]

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment						
Moderate permeability.	Fair stability and compaction; moderate to high compressibility.	Good drainage; infrequent flooding.	Infrequent flooding.	(1)----------	Infrequent flooding.	Severe: infrequent flooding.	Severe: infrequent flooding.
Moderate permeability.	Fair stability and compaction; moderate to high compressibility.	Fluctuating water table; infrequent flooding.	Fluctuating water table; infrequent flooding; salinity.	(1)----------	Infrequent flooding; fluctuating water table.	Severe: infrequent flooding; fluctuating water table.	Severe: infrequent flooding; fluctuating water table.
Moderate permeability; moderately deep over caliche.	Moderate shear strength; moderate shrink-swell potential; high compressibility.	Good drainage.	(1)----------	(1)----------	(2)----------	Severe: moderately deep over caliche.	Severe: moderately deep over caliche.
Moderate permeability; shallow soils.	Moderate permeability; shallow soils; caliche outcrops.	Excessive drainage.	(1)----------	(1)----------	(2)----------	Severe: very shallow over caliche.	Severe: very shallow over caliche.

TABLE 8.—*Engineering*

Soil series and map symbol	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand and gravel	Road subgrade	Road fill	Highway location	Dikes and levees
Church: Ch	Poor: high clay content, saline.	Not suitable	Poor	Fair	Fluctuating water table; occasional flooding from surface runoff; somewhat poor drainage.	([1])
Colby. Mapped only with Ulysses soils.	Good	Not suitable	Fair	Good	Good drainage	Moderate permeability; poor to fair stability.
Drummond: Dc. For Church part of unit Dc, refer to Church series.	Poor: salinity and variable texture.	Not suitable	Poor	Fair	Fluctuating water table.	([1])
Elkader: Ek	Fair	Not suitable	Poor to fair	Fair	Good drainage; high in calcium carbonate.	Erodible slopes; low shear strength; high in calcium carbonate.
Grigston: Gs	Good	Not suitable	Fair	Good	Good drainage; occasional flooding.	Moderate permeability; fair compaction.
Harney: Ha, Hr. For Richfield part of unit Hr, refer to Richfield series.	Good	Not suitable	Fair	Good	Good drainage	Fair stability; moderately slow permeability.
Keith: Ka	Good	Not suitable	Fair	Good	Good drainage	Moderate permeability; moderate shear strength; fair stability.

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued							Soil limitations for sewage disposal	
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Reservoir area	Embankment							
Moderately slow to slow permeability; fluctuating water table.	Fair stability; fair to good compaction; moderate to high compressibility.	Fluctuating water table; somewhat poor drainage.	Moderately slow to slow permeability; salinity and alkalinity; fluctuating water table.	(1)	Moderate to high shrink-swell potential; occasional flooding.	Severe: moderately slow to slow permeability; fluctuating water table.	Severe: occasional flooding; fluctuating water table.
Moderate permeability.	Poor to fair stability; fair compaction; high compressibility.	Good drainage.	Gentle to strong slopes.	Gentle to strong slopes; moderate to high erodibility.	(2)	Slight on slopes of less than 5 percent; moderate on slopes of 5 to 10 percent; severe on slopes of more than 10 percent.	Moderate: moderate permeability; severe on slopes of more than 7 percent.
(1)	(1)	Fluctuating water table.	(1)	(1)	Moderate to high shrink-swell potential.	Severe: slow permeability; occasional flooding; fluctuating water table.	Severe: occasional flooding; fluctuating water table.
Moderate permeability.	Poor to fair compaction.	Good drainage.	Moderate permeability; high in calcium carbonate.	Moderate to high erodibility.	(2)	Slight	Moderate: moderate permeability.
Moderate permeability.	Moderate shear strength; moderate permeability; moderate shrink-swell potential; fair compaction.	Good drainage; occasional flooding.	Occasional flooding.	(1)	Occasional flooding.	Severe: occasional flooding.	Severe: occasional flooding.
Moderately slow permeability.	Moderate to high shrink-swell potential; fair stability and compaction; moderate to high compressibility.	Good drainage; moderately slow permeability.	Moderately slow permeability.	(2)	Moderate to high shrink-swell potential.	Moderate: moderately slow permeability.	Slight.
Moderate permeability.	Moderate permeability; moderate shear strength; fair stability; fair to good compaction.	Good drainage.	Moderate permeability.	(2)	Moderate shrink-swell potential.	Moderate: moderate permeability.	Moderate: moderate permeability.

TABLE 8.—*Engineering*

Soil series and map symbol	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand and gravel	Road subgrade	Road fill	Highway location	Dikes and levees
Kim: Km For Penden part of unit Km, refer to Penden series.	Fair: low fertility.	Not suitable	Poor to fair	Good	Good drainage	Moderate shear strength; fair stability.
Minnequa: Mb	Fair above substratum; poor in substratum.	Not suitable	Poor to fair	Fair	Highly erodible; high in calcium carbonate.	Highly erodible; high in calcium carbonate.
Ness: Ne	Poor	Not suitable	Poor	Poor	Poor drainage; depressions fill with runoff water.	Very slow permeability; moderate to high shrink-swell potential.
Otero:						
Of	Poor	Good for sand; fair for gravel in local pockets.	Good	Good	Good drainage	Moderately rapid permeability.
Oh For fine sandy loam part of Oh, see unit Of in Otero series. For Tivoli part of Oh, see Tivoli series.	Poor	Good for sand; poor for gravel.	Good if confined.	Good if confined.	Excessively drained; unstable slopes.	Rapid permeability; fair to poor stability.
Penden: Pe, Pf, Ph, Pk For Kim part of unit Pk, refer to Kim series.	Good	Not suitable	Poor to fair	Good	Good drainage	Moderate shear strength; fair stability.
Richfield: Rm, Rn, Ro, Rp For Ulysses part of units Ro and Rp, refer to Ulysses series.	Good	Not suitable	Poor to fair	Fair to good	Good drainage	(2)

See footnotes at end of table.

interpretations—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Foundations for low buildings	Septic tank filter field	Sewage lagoons
Reservoir area	Embankment						
Moderately slow permeability.	Fair stability; moderate to high shrink-swell potential; moderate shear strength.	Good drainage.	(1)	(1)	Moderate to high shrink-swell potential.	Moderate to severe: moderate to strong slopes.	Moderate to severe: moderate to strong slopes.
Highly erodible; moderately deep over chalk.	Highly erodible	Good drainage.	(1)	(1)	Low to moderate shrink-swell potential.	Severe: moderately slow permeability; moderately deep over chalk.	Severe: moderately deep over chalk.
(1)	(1)	Depressional ponding; few outlets for surface drainage.	Depressional ponding; few outlets for surface drainage; very slow permeability.	(1)	Moderate to high shrink-swell potential.	Severe: very slow permeability; frequently ponded.	Severe: frequently ponded.
Moderately rapid permeability.	Well graded; low compressibility; good compaction; susceptible to piping.	Good drainage.	Moderately rapid permeability; moderate to low available water capacity.	(1)	(2)	Slight on slopes of less than 5 percent; moderate on slopes of 5 to 8 percent.	Severe: moderately rapid permeability.
(1)	Rapid permeability; fair to poor stability.	Excessive drainage.	(1)	(1)	Fair to poor stability.	Severe: rapid permeability; possibility of pollution of ground water.	Severe: rapid permeability.
Moderately slow permeability.	Moderate to high shrink-swell potential; fair stability.	Good drainage; moderately slow permeability.	(1)	(2)	Moderate to high shrink-swell potential.	Moderate on slopes of less than 10 percent; severe on slopes of more than 10 percent.	Slight on slopes of less than 2 percent; moderate on slopes of 2 to 7 percent; severe on slopes of more than 7 percent.
Moderately slow permeability.	Low to moderate shear strength; moderate to high shrink-swell potential.	Good drainage.	(2)	(2)	Moderate to high shrink-swell potential.	Moderate: moderately slow permeability; gentle slopes.	Slight on slopes of less than 2 percent; moderate on slopes of 2 to 6 percent.

TABLE 8.—*Engineering*

Soil series and map symbol	Suitability as source of—				Soil features affecting—	
	Topsoil	Sand and gravel	Road subgrade	Road fill	Highway location	Dikes and levees
Roxbury: Rx	Good	Not suitable	Poor to fair	Good	Good drainage	Moderate shear strength; fair stability.
Tivoli: Ts	Poor	Good for sand; poor for gravel.	Good if confined.	Good if confined.	Excessive drainage; unstable slopes.	Rapid permeability; fair to poor stability.
Ulysses: Ua, Ub, Uc, Ud, Ue, Um, Un. For Colby part of units Ue, Um, and Un, refer to Colby series.	Good	Not suitable	Fair to good	Poor to good	Good drainage	Moderate permeability; fair to poor stability.

[1] Practice not applicable or not needed.
[2] No features that significantly affect design.

Sites for reservoirs and pond embankments are not available in areas of Ness, Church, and Drummond soils because these soils are in undrained depressions. Dugouts, however, can be constructed on these soils. Sites for reservoirs and embankment are lacking in most areas of Canlon, Campus, and Tivoli soils, and in drainageways that contain pockets of sand.

The features that affect the suitability of soils for irrigation are shown in table 8. The management of irrigated soils is discussed in the section "General Management of Irrigated Soils."

Formation and Classification of the Soils

This part of the survey tells how the factors of soil formation have affected the development of soils in Lane County. It also explains the system of soil classification currently used and classifies each soil series in the county according to that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agents. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

Parent material is the unconsolidated material from which the soil develops. It is formed by the physical

interpretations—Continued

Soil features affecting—Continued						Soil limitations for sewage disposal	
Farm ponds		Agricultural drainage	Irrigation	Terraces and diversions	Foundations for low buildings	Septic tank filter fields	Sewage lagoons
Reservoir area	Embankment						
Moderate permeability.	Moderate shear strength; fair stability; moderate shrink-swell potential.	Good drainage.	(2)	(1)	Moderate shrink-swell potential.	Severe: occasional flooding.	Severe: occasional flooding.
(1)	Rapid permeability; fair to poor stability.	Excessive drainage.	(1)	(1)	Fair to poor stability.	Severe: rapid permeability; possibility of pollution of ground water.	Severe: rapid permeability.
Moderate permeability; moderate shrink-swell potential.	Low to moderate shear strength; fair to good compaction.	Good drainage.	Relief: nearly level and gently to strongly sloping.	(2)	Moderate shrink-swell potential.	Slight on slopes of less than 5 percent; moderate on slopes of 5 to 10 percent; severe on slopes more than 10 percent.	Moderate: moderate permeability; severe on slopes of more than 7 percent.

weathering of rocks caused by freezing and thawing, blowing, and grinding away by rivers and glaciers, and by chemical weathering. Parent material affects the texture, structure, color, natural fertility, and many other properties of the soil. Soils differ partly because of differences in their parent material. The texture of the parent material regulates the downward movement of the water and greatly influences soil development.

Most of the soils of Lane County formed from loess or similar silty sediments and from alluvial deposits (fig. 22). The silty upland soils of the High Plains were derived from loess of the Sanborn Formation deposited over the area by great duststorms (*8*). The soils in alluvium formed from sediments more recently deposited by intermittent streams. The sandy soils in the southwestern part of the county developed from partly reworked sandy deposits. A few soils in the county formed from outwash material. This material was eroded from the Rocky Mountain area and was deposited over the High Plains before the loess sediments (*7*).

The loess was deposited as a mantle a few to many feet thick over much of the area during the Wisconsin Stage of the Pleistocene Series (*9*). It is pale brown, calcareous, and friable and is more than 50 percent silt. The Peorian and Bignell loess of the Sanborn Formation is the parent material from which the Colby, Harney, Keith, Richfield, and Ulysses series formed.

Alluvium, consisting of mixtures of sand, gravel, silt, and clay, was deposited in the stream valleys and to some extent in upland drainageways. Soil formation in alluvium varies according to topographic position and the type of material deposited. The loamy soils in Lane County formed in alluvium along the drainageways of the upland. Grigston soils occur along the drainageways on high terraces and in swales. Bridgeport and Roxbury soils occur on the flood plains and low terraces. The alluvium along Walnut and Hackberry Creeks ranges from a few feet to 30 feet in thickness.

Moderately coarse textured and coarse-textured eolian materials were apparently deposited after the loess. These deposits are in the southwestern part of the county, in association with the depressional area. Most of this area is undulating and hummocky. Otero and Tivoli soils formed in this eolian material.

The unconsolidated outwash of the Pleistocene from which the Penden and Campus soils formed contrasts with the eolian sands, the reworked sandy outwash, and the cemented caliche of the Ogallala Formation. The unconsolidated outwash is highly susceptible to weathering, whereas the cemented caliche is resistant to weathering. Canlon soils, which are thin over caliche, are examples of soils weathered from caliche.

The weakly consolidated Smoky Hill Chalk of the Niobrara Formation is highly susceptible to weathering. In many areas, however, geologic erosion has removed the

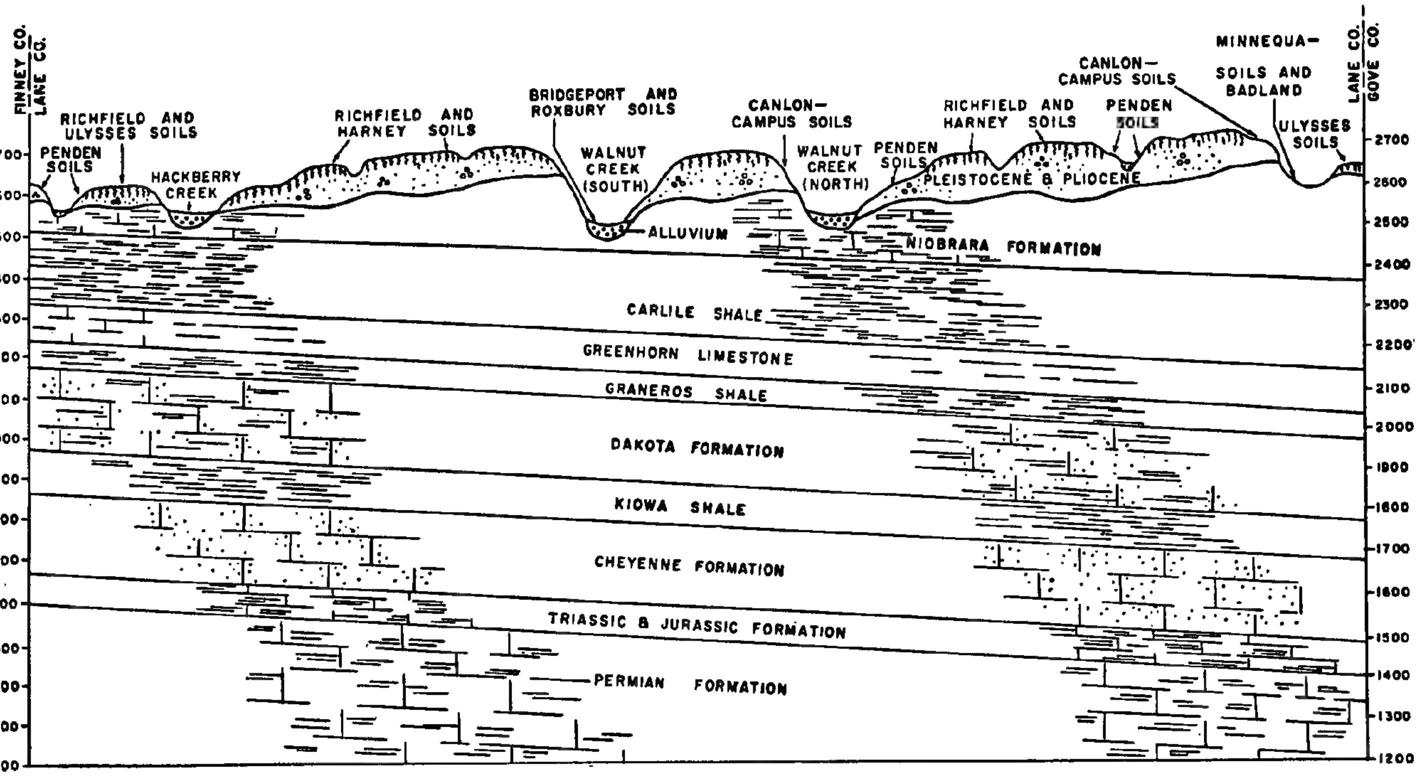

***Figure 22.*—A cross section of Lane County soils extending in a south-north direction across the county near Pendennis.**

material about as fast as it has weathered from the chalk rock. As a result there has been little soil development. These are the areas of Badland. In areas where material weathered from the chalk rock has accumulated, the Elkader and Minnequa soils have formed.

The Fort Hays Limestone Member of the Niobrara Formation and the Blue Hill Shale Member of the Carlile Shale are exposed mainly in small, isolated outcrops in the southeast corner of the county (*13*). No soils in Lane County have formed from these formations.

Climate

Climate influences both the physical and chemical processes of weathering and the biological forces at work in the soil material. Generally, if the supply of moisture is adequate, the soil-forming processes become more active as the soil temperature increases. They are limited by either inadequate or excess moisture.

The soils of Lane County formed under a dry, subhumid climate that is transitional to semiarid. Summers are hot, and winters are moderately cold. The average annual precipitation is 19 inches. The climate significantly affects soil development.

Temperature affects the decomposition of organic matter, the growth of organisms, and the rate of chemical reaction in soils. The small amount of precipitation in Lane County limits the kinds of plants. Mid and short grasses, which require little moisture, make up the principal native vegetation.

The downward movement of water is one of the main factors in the transformation of the parent material into a soil that has differential horizons. As water moves downward through the soil, calcium carbonate and salts are leached from the upper part and carried downward to form a horizon of enrichment. The translocation of clay is partly caused by the downward movement of water.

The amount of water that actually percolates downward through the soil depends not only on rainfall, temperature, humidity, and soil material, but also on relief, or lay of the land. The steep soils in Lane County, for example, have a more weakly developed profile than the nearly level soils.

More information about precipitation and temperature in Lane County is given in the section "Climate."

Plant and animal life

Soil formation is accompanied by development of vegetation. As the soil features change, the plant cover adjusts itself accordingly. In a given climatic region, the growth of a plant cover is determined mainly by the kind of parent material. The type and amount of vegetation, in turn, influence the color, structure, and other physical and chemical properties of the soils. The soils in Lane County formed under short and mid grasses.

Animal life consisting of bacteria, fungi, and other organisms aids in weathering rock and in decomposing organic matter. These organisms influence the chemical, physical, and biological processes that strongly affect soil formation. The numerous worm casts in the friable calcareous silty soils in Lane County are evidence of the presence of organisms in the soils. Krotovinas made by rodents that burrow into the soil are common in the friable, loessal soils of the county. Occasionally, channels filled with pale-brown, loessal parent material occur in the darkened subsoil. Channels filled with outwash sedi-

ments from layers below occur in the substratum of the soils of the upland.

Man has a great effect on the development of soil. Management of the soil is a primary factor in this county. Practices used to control erosion are changing the relief or lay of the land. Land leveling for irrigation in some locations has removed the developed upper layer of the soil and exposed the calcareous subsoil and substratum, both of which are deficient in plant nutrients. In this way, land leveling has offset the normal processes of soil formation (*6*).

Relief

Relief affects soil development through its effect on (1) the amount of water retained, (2) erosion, (3) the direction that material in suspension or solution is moved, and (4) the plant cover. On the steep slopes the continued removal of surface soil and the loss of water through runoff slow down the processes of soil formation. The soils in nearly level and depressed areas receive the same amount of precipitation annually as the soils on the steeper slopes, plus the runoff and deposition from the sloping areas. Consequently, these soils are generally more strongly developed than those in the sloping areas and have a deeper, darker colored surface layer.

Time

The length of time required for soil development depends mainly on the other factors of soil formation. Soils develop slowly in a dry climate under sparse vegetation and much more rapidly in a moist climate under dense vegetation. The type of parent material influences the length of time required for a soil to reach a state of equilibrium with its environment. Soils that formed in loess in the sloping areas of this county show weaker development than those that formed in the nearly level areas. The actual age of the loess is probably the same, but the apparent age indicated by the soil profile differs. The continual loss of surface soil through erosion removes the developed material and exposes material relatively unaltered by soil-forming processes. For example, the Harney soils in the nearly level areas lose little material; consequently, they are deep and strongly developed.

Classification of the Soils

Classification consists of an orderly grouping of soils according to a system designed to make it easier to remember soil characteristics and interrelationships. Classification is useful in organizing and applying the results of experience and research. Soils are placed in narrow classes for discussion in detailed soil surveys and for application of knowledge within farms and fields. The many thousands of narrow classes are then grouped into progressively fewer and broader classes in successively higher categories, so that information can be applied to large geographic areas.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*15*). The system currently used by the National Cooperative Soil Survey was developed in the early sixties (*14*) and was adopted in 1965 (*17*). It is under continual study.

The current system of classification has six categories. Beginning with the most inclusive, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. The criteria for classification are soil properties that are observable or measurable, but the properties are selected so that soils of similar genesis are grouped together. The placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.

Table 9 shows the classification of each soil series of Lane County by family, subgroup, and order, according to the current system.

Order.—There are ten soil orders. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate these soil orders are those that tend to give broad climatic groupings of soils. The two exceptions are Entisols and Histosols, both of which occur in many different kinds of climate. Five soil orders are recognized in Lane County: Entisols, Aridisols, Mollisols, Alfisols, and Vertisols.

Entisols are light-colored soils that do not have natural genetic horizons or that have only very weakly expressed beginnings of such horizons. These soils do not have traits that reflect soil mixing caused by shrinking and swelling.

Aridisols are light-colored mineral soils that are high in bases and have well-expressed mineral genetic horizons.

Mollisols formed under grass and have a thick, dark-colored surface horizon containing colloids dominated by bivalent cations. The soil material in these soils has not been mixed by shrinking and swelling.

Alfisols are mineral soils that contain horizons of clay accumulation. Unlike the Mollisols, they lack a thick, dark-colored surface layer that contains colloids dominated by bivalent cations, and they have some base accumulation in the lower horizons.

Vertisols are clay soils that swell and shrink enough to cause cracking, shearing, and mixing of the soil material when climate and relief result in alternate wetting and drying of the soil mass.

Suborder.—Each order is divided into suborders, primarily on the basis of soil characteristics that seem to produce classes having the greatest genetic similarity. A suborder has a narrower climatic range than an order. The criteria for suborders reflect either (1) the presence or absence of waterlogging or (2) differences in climate or vegetation.

Great Groups.— Each suborder is divided into great groups on the basis of uniformity in kind and sequence of genetic horizons and major soil features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those in which a pan interferes with the growth of roots or movement of water. Among the features considered are the self-mulching properties of clays, the soil temperature, and major differences in chemical composition, mainly calcium, magnesium, sodium, and potassium.

Subgroup.—Each group is divided into subgroups, one representing the central (typic) concept of the group, and others, called intergrades, representing the soils that have mostly the properties of one great group but also have one or more properties of another great group, suborder, or order.

TABLE 9.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Bridgeport	Fine-silty, mixed, mesic	Torriorthentic Haplustolls	Mollisols.
Campus	Fine-loamy, mixed, mesic	Typic Calciustolls	Mollisols.
Canlon	Loamy, mixed, calcareous, mesic	Lithic Ustorthents	Entisols.
Church [1]	Fine, mixed, mesic	Aquic Camborthids	Aridisols.
Colby	Fine-silty, mixed, calcareous, mesic	Ustic Torriorthents	Entisols.
Drummond [2]	Fine, mixed, thermic	Mollic Natrustalfs	Alfisols.
Elkader	Fine-carbonatic, mesic	Aridic Haplustolls	Mollisols.
Grigston	Fine-silty, mixed, mesic	Fluventic Haplustolls	Mollisols.
Harney	Fine, montmorillonitic, mesic	Typic Argiustolls	Mollisols.
Keith	Fine-silty, mixed, mesic	Aridic Argiustolls	Mollisols.
Kim [3]	Fine-loamy, mixed, calcareous, mesic	Ustic Torriorthents	Entisols.
Minnequa	Fine-carbonatic, mesic	Ustic Torriorthents	Entisols.
Ness	Fine, montmorillonitic, mesic	Udic Pellusterts	Vertisols.
Otero	Coarse-loamy, mixed, calcareous, mesic	Ustic Torriorthents	Entisols.
Penden	Fine-loamy, mixed, mesic	Typic Calciustolls	Mollisols.
Richfield	Fine, montmorillonitic, mesic	Aridic Argiustolls	Mollisols.
Roxbury	Fine-silty, mixed, mesic	Cumulic Haplustolls	Mollisols.
Tivoli [2]	Mixed, thermic	Typic Ustipsamments	Entisols.
Ulysses	Fine-silty, mixed, mesic	Aridic Haplustolls	Mollisols.

[1] The Church soil in Lane County is a taxadjunct to the Church series because the mean annual precipitation is a few inches more than the range defined for the Church series.

[2] The Drummond and Tivoli soils in this county are taxadjuncts to the Drummond and Tivoli series because the annual temperature is a few degrees cooler than the range defined for the series.

[3] The Kim soil in this county is a taxadjunct to the Kim series because the lime content of the C1ca and C2 horizons is slightly higher than the range defined for the Kim series.

Family.—Families are established within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence.

General Facts About the County

Lane County was organized in 1873. At that time it included parts of Gove, Hodgeman, and Finney Counties. Dighton, the county seat, is near the center of the county, where State Highway No. 96 intersects State Highway No. 23. Dighton, Healy, and Alamota are the principal towns. Grain handling and storage facilities at Dighton, Healy, Alamota, Shields, Amy, and Pendennis are connected by rail to terminal elevators and markets to the east and west. State Highways 96 and 4 cross the county from east to west, and Highway 23 crosses from north to south.

In most areas water is obtained from wells drilled into the reservoir of ground water in the Ogallala Formation. The depth to the water table in this formation ranges from 20 to about 170 feet. There are areas in the county where wells cannot be developed without drilling into the Dakota Formation, which is at a depth of 400 to more than 1,000 feet. These areas are in the northernmost 3 miles of the county and in the southwestern and southeastern parts.

Much of the water for livestock is hauled in large tanks by trucks from Dighton and from farmsteads. Many impoundments have been built across intermittent drainageways in the upland. There are several springs along the larger creeks. Sufficient water for irrigation is pumped from deep wells, mostly in the north-central part of the county. A few ponds are used as reservoirs to catch and impound water for irrigating small acreages.

Climate [6]

Lane County has a semi-arid, continental climate characterized by low annual rainfall, abundant sunshine, dry atmospheric air, hot summers, and wide daily and annual variations in temperature. The county is in west-central Kansas. The elevation is about 2,700 feet above sea level. Much of the county is nearly level. There are a few low hills along the northeastern and eastern borders (*10*). Except for low rainfall, the climate is generally favorable for the growth of many farm crops. Facts about precipitation and temperature are given in table 10.

PRECIPITATION

West-central Kansas lies within the rain shadow of the Rocky Mountains, west of the northward-moving stream of moist air from the Gulf of Mexico. The greater frequency of the flow of moist air over eastern Kansas contributes to a marked increase in precipitation across the State (*4*). Annual rainfall ranges from 16 inches along the western border of southwestern Kansas to 41 inches in the southeastern corner. Thus, Lane County is just northeast of the driest area of Kansas. At Healy the average annual precipitation is only 19 inches.

Crop yields on dryland farms are frequently limited by lack of rainfall (*10*). Summer fallow, which minimizes the adverse effects of moisture deficiency, is a common practice. The fact that the bulk of the precipitation falls during the growing season is of special importance to dry-

[6] By MERLE J. BROWN, State climatologist, U.S. Weather Bureau.

land farming in the area. On the average, about 77 percent of the amount of annual moisture falls during the period April through September. Rainfall averages more than 2½ inches during each of the months from May through August. It is usually heaviest in June; the average is 3 inches for that 30-day period. Average precipitation from December through February is only 1.39 inches. In January, the driest month, it is 0.29 inch.

Precipitation is not only insufficient in Lane County but also spasmodic. During the period 1902 through 1965, annual precipitation at Healy ranged from 8.92 inches in 1956 to 36.71 inches in 1923 (fig. 23). In 1922, the year before the heaviest annual rainfall of record, annual precipitation amounted to only 13.24 inches. The year following the driest calendar year of record, 1956, rainfall at Healy totaled 27.83 inches.

A series of dry years is not uncommon. Droughts were very severe during the 1930's and again from 1952 to 1957. Palmer (*11*) has developed a system for determining the intensity and duration of meteorological droughts. Data obtained from this system show that the drought of the 1930's was the longest of any in 30 years. Drought conditions were continuous in west-central Kansas from November 1932 through October 1940. Of the 96 months of dry weather during that period, 45 months had either severe or extreme drought. The drought of the 1950's, although of shorter duration, was even more severe than the one of the 1930's. For example, during the period 1954 through 1956, only 36.13 inches of precipitation fell at Healy, whereas the average precipitation for a 3-year period is 56.97 inches.

Showers account for most of the annual moisture in Lane County, particularly in July, August, and September. Local storms occur in a scattered pattern over the area. Heavy rains may be reported in one locality while a spot nearby receives little or no rainfall.

Table 10 shows, by months, the average precipitation for Lane County. It can be noted that in 1 year out of 10, on the average, the amount of precipitation in October is less than 0.10 inch. Similarly, in each month from November through March the precipitation is 0.10 inch, or less, in 10 percent of the years. At the other extreme, precipitation in June will, on the average, exceed 5.74 inches in one out of 10 years.

Figure 24 shows the probability, in percent, of receiving specified amounts of precipitation in any week of the year. The normal weekly (smoothed) precipitation is also shown in the figure. The percentages are based on data recorded at Healy (*5*). The best chances of receiving a significant amount of moisture, that is, 0.20 inch or more, are late in May and early in June. In summer the probability of significant rainfall is least late in August. Table 11 shows the probable frequency of rainfall of specified duration and amount for stated periods (*18*). The probabilities are, for example, that a 30-minute rain of 0.9 inch can be expected once a year, and a 30-minute rain of 2.8 inches once in 100 years.

Snowfall in Lane County averages about 20 inches annually. It has ranged from a total of 3 inches in the winter of 1932–33 to 74 inches in 1957–58. One of the longest periods for a continuous snow cover was 50 days in the winter of 1939–40. Blizzards occur but are infrequent.

Temperature

Because of the elevation and the influence of the surrounding land mass, daily and annual temperatures vary greatly. Frequent cloudless or nearly cloudless skies and dry atmospheric air result in warm days and cool nights. Even in July, the hottest month, the nights are usually cool. The average daily minimum temperature during that month is 63° F.

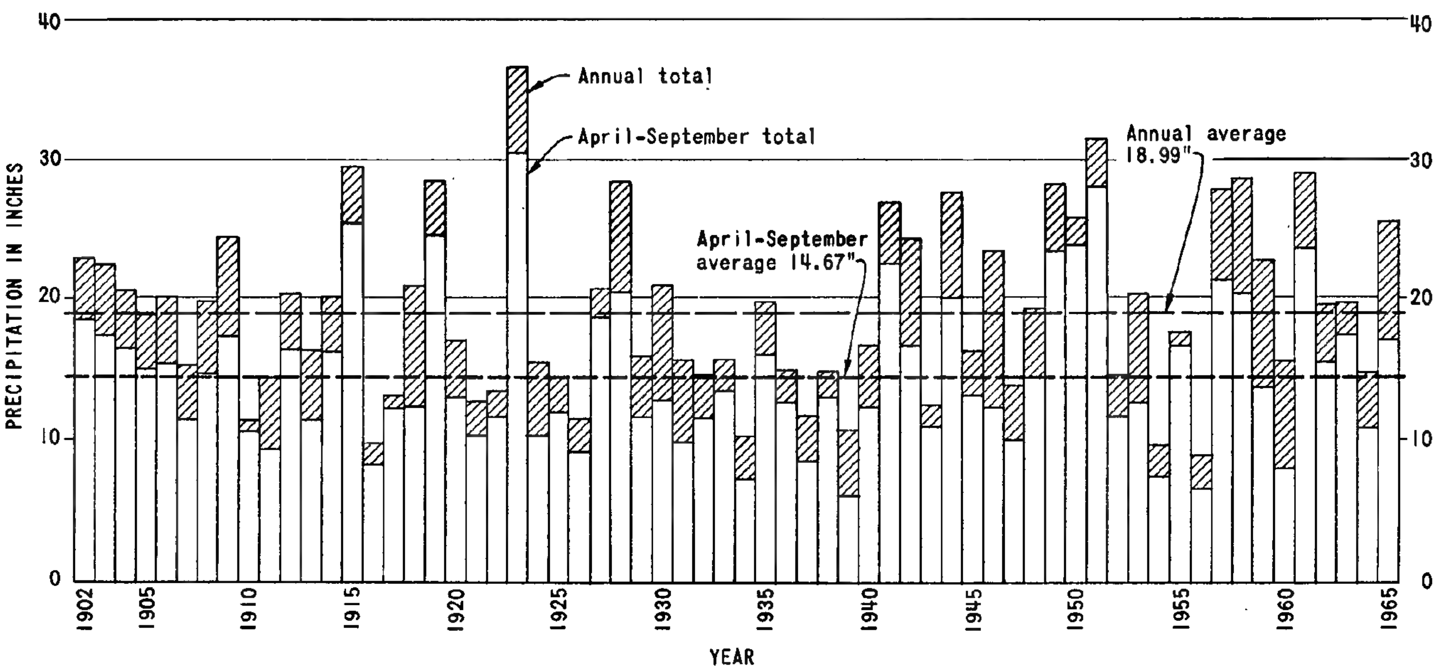

Figure 23.—Annual precipitation and precipitation from April through September at Healy, Kans., for the period 1902 through 1965. White part of bar represents precipitation from April through September. White part plus shaded part represents annual precipitation.

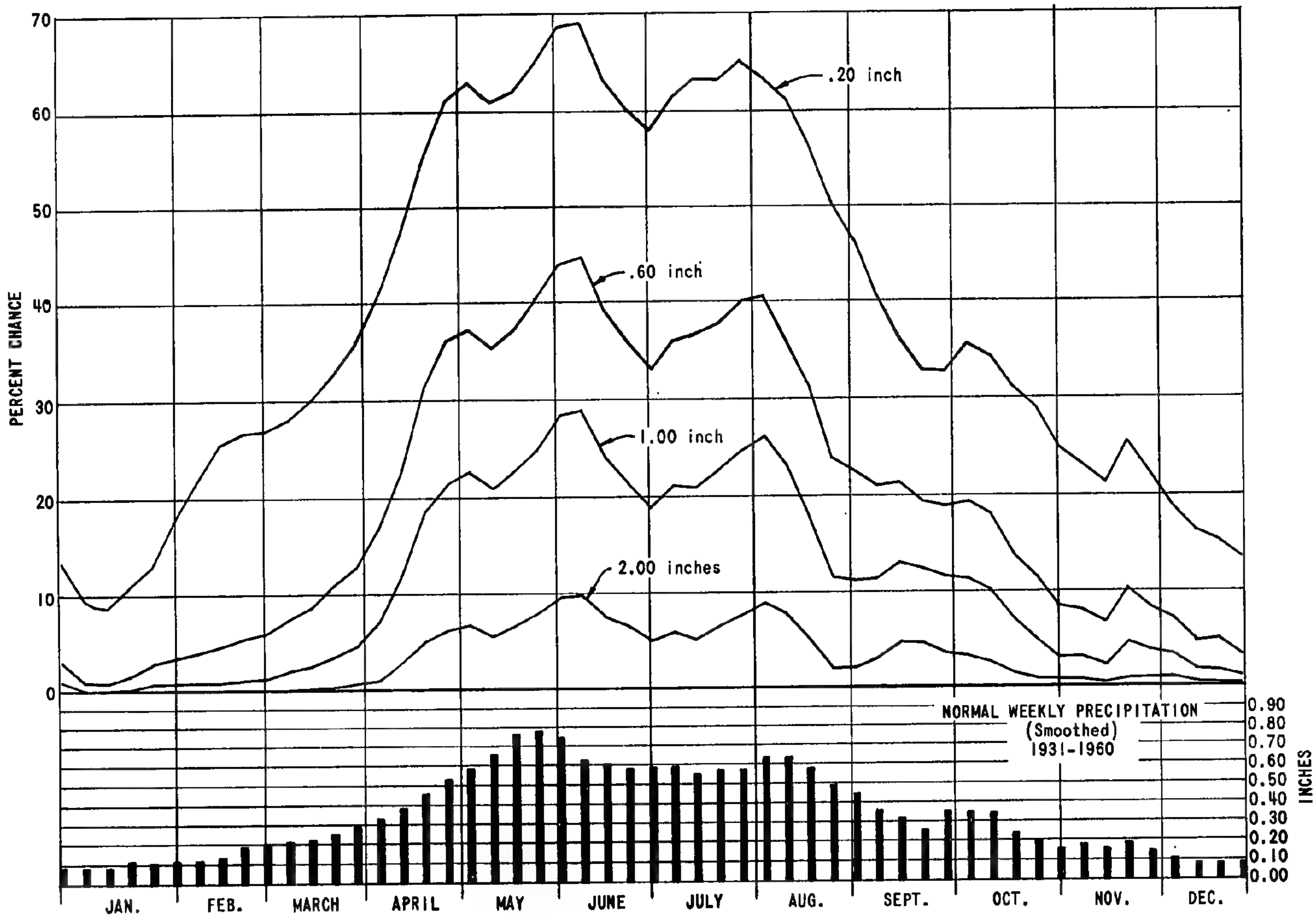

Figure 24.—**Probabilities, in percent, of receiving at least the specified amount of precipitation by weeks. The normal amount of weekly precipitation is shown at the bottom of this figure.**

A daily temperature range of 35° is not unusual in Lane County. Daily temperature variations exceeding 45° occur at times, particularly in spring and fall. Occasionally, except in summer, the temperature is moderated by warm chinook winds blowing downslope from higher elevations to the west.

The intense heat in summer and the occasional surges of cold air from northern latitudes in winter contribute to a wide range in annual temperature. The average monthly temperature at Healy has ranged from 29.5° in January to 78° in July. Temperature extremes have ranged from a low of 31° below zero to a high of 116° (fig. 25). Table 10 gives the average daily maximum and minimum temperatures, by months, and also gives information on the probability of very high or very low temperatures. In January, for example, an average of 2 years in 10 will have at least 4 days when the minimum temperature is equal too or lower than −3°. At the other extreme, 2 years in 10, on the average, will have at least 4 days in July and in August when the maximum temperature is equal to or higher than 104°. During the period of record 1902 through 1965 at Healy, there were only two summers, 1915 and 1941, in which the temperature failed to reach 100° or higher. A minimum of zero or below has been recorded in every year since the weather station was first established at Healy.

The average freeze-free period is about 165 days (*3*). It is 35 days shorter than the average along the southern border of southeastern Kansas, but it is 15 days longer than the average freeze-free period in northwestern corner of the State. At Healy, the latest date in spring of a temperature of 32° or below was May 27, 1907 and 1950. The earliest date of a 32° temperature in fall was September 12, 1902. Rarely is the freeze-free period in Lane County less than 130 days or more than 200 days.

The probabilities for the last freeze in spring and the first in fall are given for five freeze thresholds in table 12. Data in this table indicate that in half the years, on the average, the last 32° temperature in spring occurs after April 30, and the first in fall before October 15.

Crop production is adversely affected at times by a combination of high temperatures, dry weather, moderate to strong winds, and low humidity. During such periods, potential evapotranspiration is high and plants are unable to obtain enough water to maintain a satisfactory growth rate.

TABLE 10.—*Temperature and precipitation*

[Data from Healy, Lane County, Kans.]

Month	Temperature: Average daily maximum [1]	Temperature: Average daily minimum [1]	Two years in 10 will have at least 4 days with —[2] Maximum temperature equal to or higher than—	Two years in 10 will have at least 4 days with —[2] Minimum temperature equal to or lower than—	Precipitation: Average total	One year in 10 will have—[1] Less than—	One year in 10 will have—[1] More than—	Days with snow cover [3]	Average depth of snow on days with snow cover [3]
	° F.	° F.	° F.	° F.	Inches	Inches	Inches	Number	Inches
January	43. 8	15. 4	63	−3	0. 29	0. 01	0. 83	8	3. 6
February	48. 2	18. 7	67	2	0. 57	0. 10	1. 29	7	2. 4
March	56. 6	25. 6	77	7	0. 92	0. 08	2. 26	5	5. 4
April	67. 6	36. 8	85	22	1. 78	0. 42	3. 77	1	2. 4
May	76. 2	47. 4	91	35	2. 84	1. 00	5. 36		
June	86. 7	57. 8	101	47	3. 00	0. 97	5. 74		
July	92. 7	63. 2	104	57	2. 68	0. 71	4. 82		
August	91. 7	62. 2	104	55	2. 70	0. 65	5. 33		
September	83. 8	53. 1	98	40	1. 67	0. 34	3. 82		
October	71. 7	40. 0	88	28	1. 31	0. 08	2. 56	(4)	1. 0
November	56. 6	26. 3	72	11	0. 70	0. 01	1. 79	3	3. 6
December	45. 3	18. 1	65	6	0. 53	0. 02	1. 23	8	2. 6
Year	68. 4	53. 6	[5] 106	[6] −12	18. 99	10. 56	28. 30	32	3. 3

[1] Period 1901–61.
[2] Period 1936–60.
[3] Period 1936–65.
[4] Less than 0.5 day.
[5] Average annual highest maximum 1901–61.
[6] Average annual lowest minimum 1901–61.

TABLE 11.—*Frequency of specified amounts of rainfall during stated time intervals*

Frequency	Inches of rainfall for duration of— ½ hour	1 hour	2 hours	3 hours	6 hours	12 hours	24 hours
Once in—							
1 year	0. 9	1. 2	1. 3	1. 4	1. 6	1. 7	1. 9
2 years	1. 1	1. 5	1. 7	1. 7	2. 0	2. 3	2. 4
5 years	1. 6	2. 0	2. 3	2. 4	2. 7	3. 0	3. 3
10 years	1. 9	2. 4	2. 7	2. 8	3. 2	3. 6	4. 0
25 years	2. 3	2. 8	3. 3	3. 3	3. 7	4. 4	4. 7
50 years	2. 5	3. 2	3. 6	3. 8	4. 4	4. 8	5. 5
100 years	2. 8	3. 6	4. 0	4. 3	4. 8	5. 8	5. 8

Storms and Winds

Some of the violent thunderstorms produce a heavy downpour of rain, and some produce large hail and isolated tornadoes. Hail probably causes more damage than any other type of storm. The frequency of a hailstorm increases significantly from east to west across Kansas, whereas the amount of rainfall, as previously mentioned, increases eastward across the State. Thus, Lane County has more hail and less rainfall than counties farther to the east. Hailstones range in size from a pea to a walnut. Occasionally, they are as large as a baseball and cause crop and property damage. Hailstorms are generally local in extent and of short duration. Tornadoes are infrequent but are most likely to occur in spring, summer, and early in fall. Rarely do these storms cause heavy damage or loss of life.

Surface winds are moderate to occasionally strong in all seasons. The period of strongest winds, on the average, is in spring when low pressure storm centers are most intense. During dry periods, strong winds may be accompanied by soil blowing, particularly in March and April. In recent years, however, improved soil management has reduced the amount of soil blowing.

Farming

According to the U.S. Census of Agriculture, there were 362 farms in Lane County in 1959. The average size was 1,206 acres. Few farmers own all the land they farm. The 1959 census shows 69 operators as full owners, 187 as part owners, and 106 as tenants. Many farm families have moved to nearby towns in recent years because of

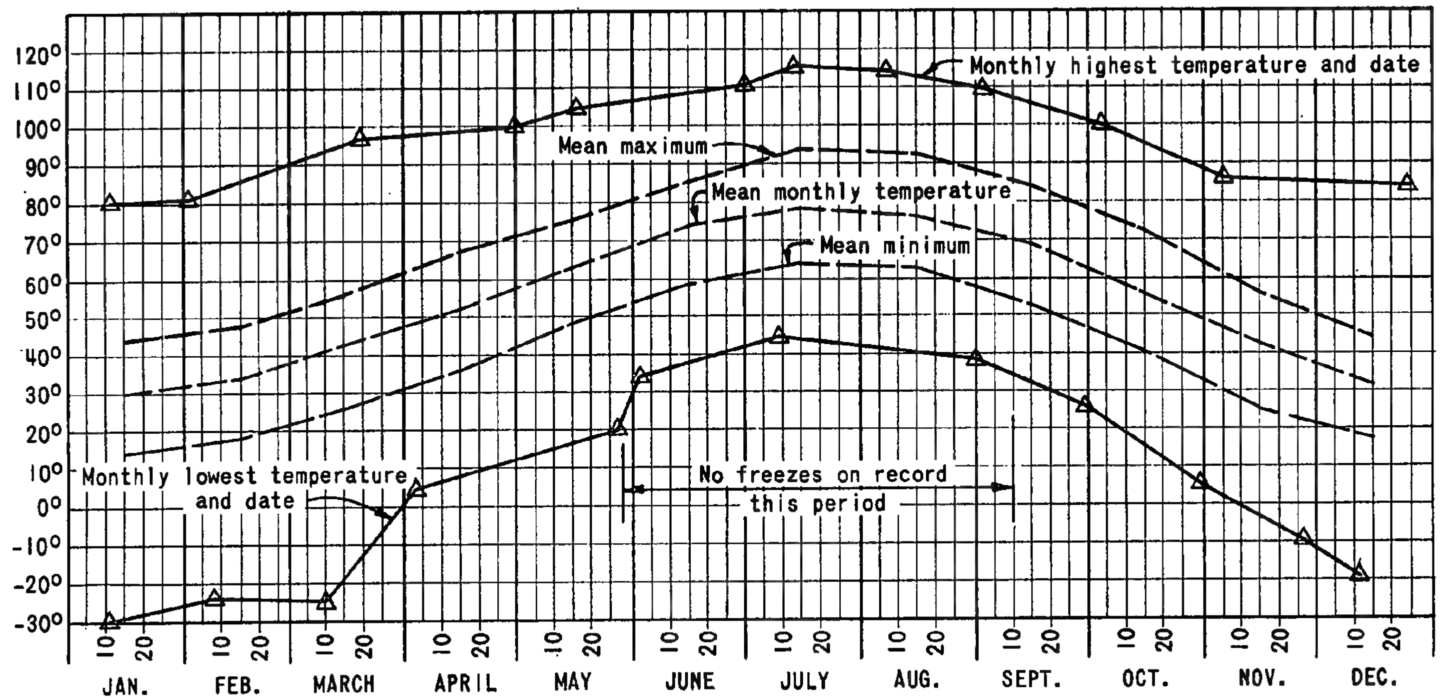

Figure 25.—Means and extremes of temperature at Healy, Kans.

improved roads and the improved means of transportation.

Cash-grain crops, wheat and grain sorghum, account for more than 95 percent of the average annual crop production. In 1963, according to the Kansas State Board of Agriculture, wheat was sown on 123,000 acres and harvested from 69,000 acres. All sorghums were planted on 57,000 acres and harvested from 54,700 acres. Corn was harvested from 1,200 acres, barley from 600 acres, rye from 780 acres, oats from 380 acres, and alfalfa hay from 1,000 acres.

Wheat and grain sorghum, the only important dryland crops, are usually grown in a cropping system in which the field is fallow every other year. During the fallow period, moisture is stored for use by the following crop, and weeds are controlled to conserve moisture. Crop failures, or near failures, are common when rainfall is below average.

In 1964 about 5,500 acres was irrigated. The principal crops grown under irrigation are corn, grain sorghum, forage sorghum, alfalfa, and wheat.

About 31 percent of the acreage of Lane County is native grass and is used for range. Most of this acreage is nonarable or marginal for cultivation.

The raising of livestock, mainly feeder-stocker cattle, is the second largest farm enterprise in the county. There are cattle-breeding herds in the county, but also large numbers of cattle and sheep are brought into the county in fall when sorghum stubble and wheat are available for grazing. These animals are brought in from other areas in the State and from other States. In the past few years, the number of cattle fed in feedlots has greatly increased. In 1963, according to the Kansas State Board of Agriculture, there were 50,000 cattle, 1,300 hogs, 900 sheep, and 9,000 chickens. There were only 600 dairy cattle.

TABLE 12.—*Probability of last freezing temperature in spring and first in fall*

Probability	Dates for given probability and temperature				
	16° F. or lower	20° F. or lower	24° F. or lower	28° F. or lower	32° F. or lower
Spring:					
1 year in 10 later than	April 7	April 14	April 19	May 3	May 15
2 years in 10 later than	April 1	April 8	April 14	April 27	May 10
5 years in 10 later than	March 20	March 29	April 5	April 17	April 30
Fall:					
1 year in 10 earlier than	October 30	October 25	October 18	October 10	October 1
2 years in 10 earlier than	November 5	October 30	October 22	October 15	October 5
5 years in 10 earlier than	November 17	November 10	November 1	October 24	October 15

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates such as crumbs, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali soil. Generally, a highly alkaline soil. Specifically an alkali soil has so high a degree of alkalinity (pH 8.5 or higher) or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that the growth of most crop plants is low from this cause.

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in many soils of warm-temperate areas, as in the Southwestern States. The material may consist of soft, thin layers in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Clay. A soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Drainage, surface. Runoff, or surface flow, of water from an area.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Gilgai. Typically, the microrelief of Vertisols—clayey soils that have a high coefficient of expansion and contraction with changes in moisture; usually a succession of microbasins and microknolls, in nearly level areas, or of microvalleys and microridges that run with the slope.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or

more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Krotovinas. Irregular tubular streaks caused by the filling of tunnels made by burrowing animals with material from another horizon.

Loess. A fine-grained eolian deposit consisting dominantly of silt-sized particles.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottled. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: Abundance—*few*, *common*, and *many;* size—*fine*, *medium*, and *coarse;* and contrast—*faint*, *distinct*, and *prominent*. The size measurements are these: *fine*, less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium*, ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse*, more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Phase, soil. A subdivision of a soil type, series, or other unit in the soil classification system made because of differences in the soil that affect its management but do not affect its classification in the natural landscape. A soil type, for example, may be divided into phases because of differences in slope, stoniness, thickness, or some other characteristic that affects its management but not its behavior in the natural landscape.

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	ph		*ph*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Saline soil. A soil that contains soluble salts in amounts that impair growth of plants but that does not contain excess exchangeable sodium.

Sand. Individual rock or mineral fragments in soils having diameters ranging from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Series, soil. A group of soils developed from a particular type of parent material and having genetic horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangements in the profile.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt textural class is 80 percent or more silt and less than 12 percent clay.

Slick spots. Small areas in a field that are slick when wet because they contain excess exchangeable sodium, or alkali.

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. Technically the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

Texture. soil. The soil ordinarily moved in tillage, or its equivaparticles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt loam*, *silt*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Tilth, soil. The condition of the soil in relation to the growth of plants, especially soil structure. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable, granular structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. An explanation of the capability classification begins on page 26. Irrigated capability units are described on page 32. Windbreak groups are described on pages 38 and 39. Other information is given in tables as follows:

Acreage and extent, table 1, page 7.
Predicted yields of dryland crops, table 2, page 31.
Predicted yields of irrigated crops, table 3, page 32.

Use of the soils in engineering, table 6, page 42; table 7, page 44; and table 8, page 46.

Map symbol	Mapping unit	Described on page	Capability unit: Dryland	Capability unit: Page	Capability unit: Irrigated	Range site: Name	Range site: Page	Windbreak group: Name
An	Alluvial land-----------------	7	VIw-1	30	-----	Loamy Lowland	35	Lowland
Be	Bridgeport silt loam, 0 to 1 percent slopes--------------	9	IIc-2	28	I-1	Loamy Terrace	35	Lowland
Bg	Bridgeport silt loam, saline--	9	IVs-1	29	-----	Saline Lowland	36	------------
Cc	Canlon-Campus complex---------	10						
	Canlon-------------------	--	VIe-4	30	-----	Breaks--------	37	------------
	Campus-------------------	--	VIe-4	30	-----	Limy Upland---	34	------------
Ch	Church silty clay loam--------	11	IVs-1	29	-----	Saline Lowland	36	------------
Dc	Drummond-Church complex-------	13	VIs-1	31	-----	Saline Lowland	36	------------
Ek	Elkader silt loam, 1 to 4 percent slopes--------------	14	IIIe-3	29	-----	Limy Upland	34	Silty Upland
Gr	Gravelly broken land----------	14	VIIs-2	31	-----	Gravelly Hills	35	------------
Gs	Grigston silt loam------------	15	IIc-2	28	I-1	Loamy Terrace	35	Lowland
Ha	Harney silt loam, 0 to 1 percent slopes--------------	15	IIc-1	27	I-1	Loamy Upland	34	Silty Upland
Hr	Harney-Richfield complex, 0 to 1 percent slopes---------	16	IIc-1	27	I-1	Loamy Upland	34	Silty Upland
Ka	Keith silt loam, 0 to 1 percent slopes--------------	16	IIc-1	27	I-1	Loamy Upland	34	Silty Upland
Km	Kim-Penden clay loams, 6 to 15 percent slopes, eroded---	17	VIe-3	30	-----	Limy Upland	34	Silty Upland
Mb	Minnequa-Badland complex------	17						
	Minnequa-----------------	--	VIIs-1	31	-----	Chalk Flats	36	------------
	Badland------------------	--	VIIs-1	31	-----	--------------	--	------------
Ne	Ness clay---------------------	18	VIw-2	30	-----	--------------	--	------------
Of	Otero fine sandy loam, undulating------------------	19	IVe-1	29	-----	Sandy	35	Sandy Upland
Oh	Otero soils, hummocky---------	19						
	Otero loamy fine sand----	--	VIe-2	30	-----	Sands	35	Sandy Upland
	Otero fine sandy loam----	--	VIe-2	30	-----	Sandy	35	Sandy Upland
Pe	Penden clay loam, 1 to 3 percent slopes--------------	20	IIIe-1	29	IIe-1	Limy Upland	34	Silty Upland
Pf	Penden clay loam, 3 to 6 percent slopes--------------	20	IVe-2	29	-----	Limy Upland	34	Silty Upland
Ph	Penden clay loam, 6 to 15 percent slopes--------------	20	VIe-3	30	-----	Limy Upland	34	Silty Upland
Pk	Penden-Kim clay loams, 3 to 6 percent slopes, eroded------	20	IVe-3	29	-----	Limy Upland	34	Silty Upland
Rm	Richfield silt loam, 0 to 1 percent slopes--------------	22	IIc-1	27	I-1	Loamy Upland	34	Silty Upland
Rn	Richfield silt loam, 1 to 3 percent slopes--------------	22	IIe-1	27	IIe-1	Loamy Upland	34	Silty Upland
Ro	Richfield-Ulysses silt loams, 1 to 3 percent slopes-------	22	IIIe-1	29	IIe-1	Loamy Upland	34	Silty Upland
Rp	Richfield-Ulysses silt loams, 3 to 6 percent slopes-------	22	IIIe-2	29	-----	Loamy Upland	34	Silty Upland
Rx	Roxbury silt loam-------------	23	IIc-2	28	I-1	Loamy Terrace	35	Lowland
Ts	Tivoli loamy fine sand--------	23	VIe-2	30	-----	Sands	35	Sandy Upland
Ua	Ulysses silt loam, 0 to 1 percent slopes--------------	24	IIc-1	27	I-1	Loamy Upland	34	Silty Upland
Ub	Ulysses silt loam, 1 to 3 percent slopes--------------	24	IIIe-1	29	IIe-1	Loamy Upland	34	Silty Upland

GUIDE TO MAPPING UNITS--Continued

Map symbol	Mapping unit	Described on page	Capability unit			Range site		Windbreak group
			Dryland	Page	Irrigated	Name	Page	Name
Uc	Ulysses silt loam, 3 to 6 percent slopes--------------	24	IVe-2	29	-----	Loamy Upland	34	Silty Upland
Ud	Ulysses silt loam, 6 to 15 percent slopes--------------	24	VIe-1	30	-----	Loamy Upland	34	Silty Upland
Ue	Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded-	24	IIIe-3	29	IIe-1	Limy Upland	34	Silty Upland
Um	Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded----	24	IVe-3	29	-----	Limy Upland	34	Silty Upland
Un	Ulysses-Colby silt loams, 6 to 15 percent slopes, eroded----------------------	25	VIe-3	30	-----	Limy Upland	34	Silty Upland

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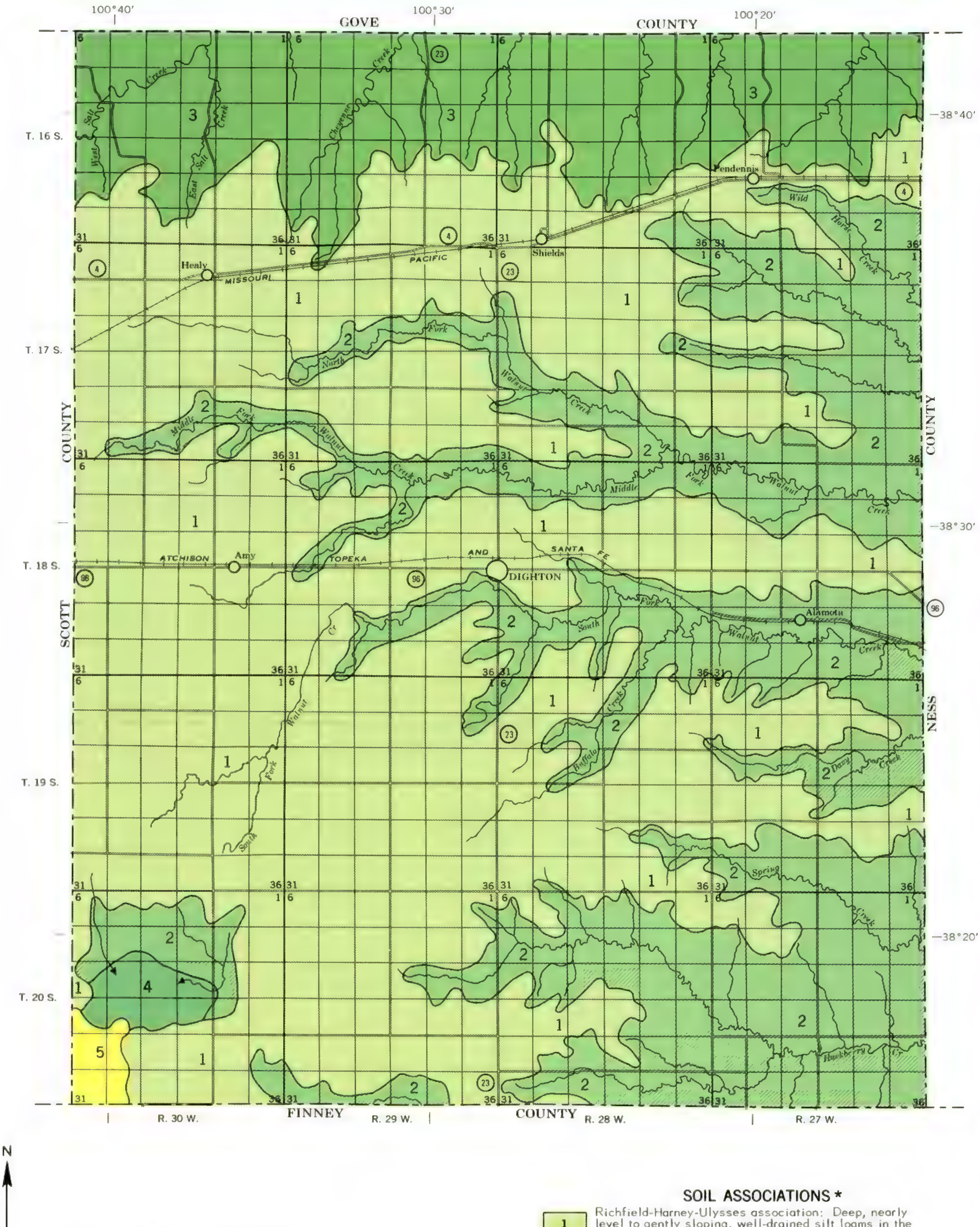


U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

LANE COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

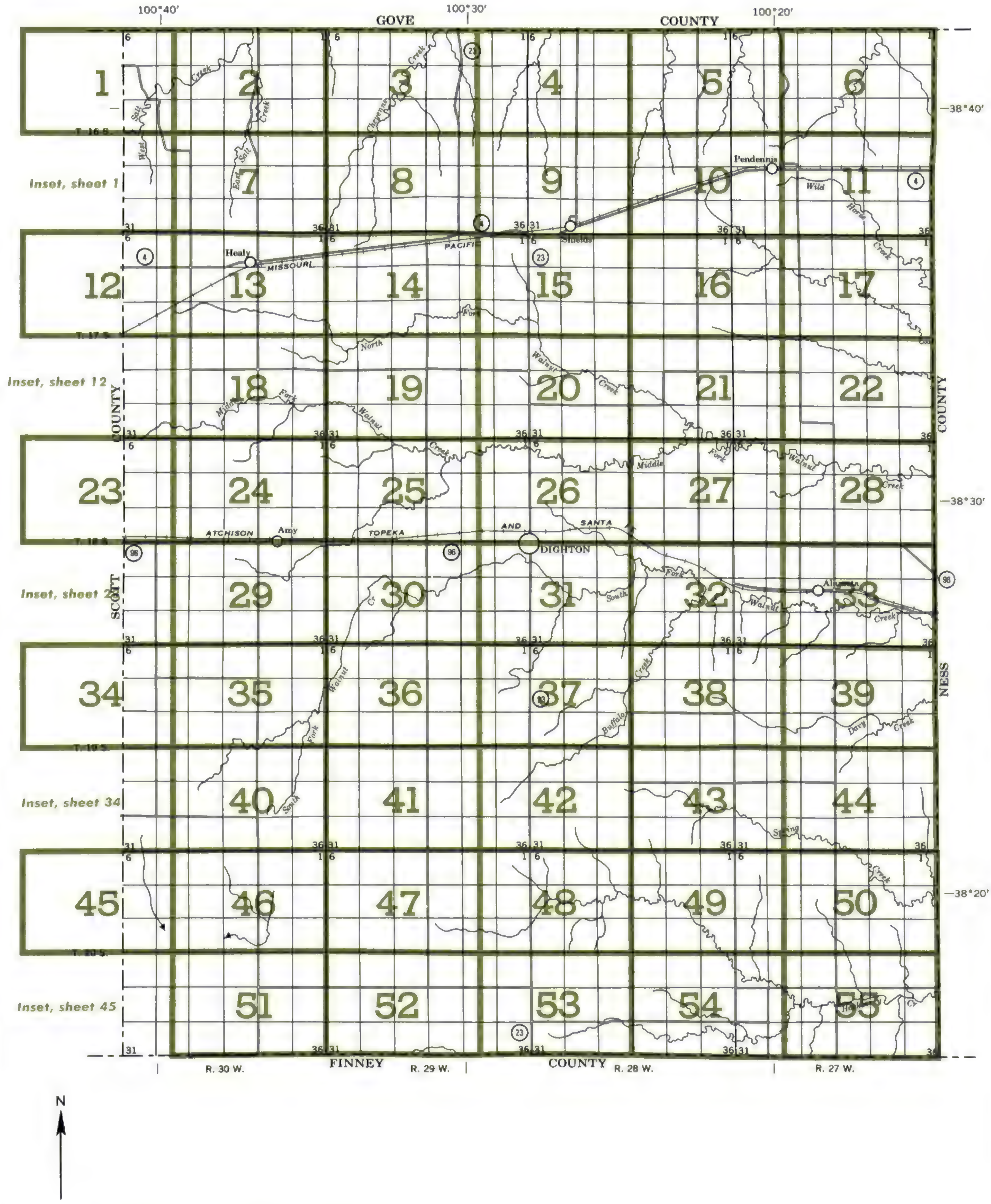
SOIL ASSOCIATIONS *

1	Richfield-Harney-Ulysses association: Deep, nearly level to gently sloping, well-drained silt loams in the uplands
2	Penden-Richfield-Ulysses association: Deep, nearly level to strongly sloping, well-drained clay loams and silt loams along drainageways in the uplands
3	Ulysses-Penden-Minnequa association: Deep and moderately deep, nearly level to strongly sloping, well-drained silt loams and clay loams in the rolling uplands
4	Church-Roxbury-Ness association: Deep, nearly level, well-drained to poorly drained silty clay loams, silt loams, and clays on floors and benches in depressions
5	Otero-Tivoli association: Deep, undulating to hilly, well-drained to excessively drained sandy loams and loamy sands in the sandhills

*Texture in name of association refers to surface layer unless otherwise stated

This map is for general planning. It shows only the major soils and does not contain sufficient detail for operational planning.

Published 1971



INDEX TO MAP SHEETS

LANE COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 4 Miles

SOIL LEGEND

SYMBOL	NAME
An	Alluvial land
Be	Bridgeport silt loam, 0 to 1 percent slopes
Bq	Bridgeport silt loam, saline
Cc	Canlon-Campus complex
Ch	Church silty clay loam
Dc	Drummond-Church complex
Ek	Elkader silt loam, 1 to 4 percent slopes
Gr	Gravelly broken land
Gs	Grigston silt loam
Ha	Harney silt loam, 0 to 1 percent slopes
Hr	Harney-Richfield complex, 0 to 1 percent slopes
Ka	Keith silt loam, 0 to 1 percent slopes
Km	Kim-Penden clay loams, 6 to 15 percent slopes, eroded
Mb	Minnequa-Badland complex
Ne	Ness clay
Of	Otero fine sandy loam, undulating
Oh	Otero soils, hummocky
Pe	Penden clay loam, 1 to 3 percent slopes
Pf	Penden clay loam, 3 to 6 percent slopes
Ph	Penden clay loam, 6 to 15 percent slopes
Pk	Penden-Kim clay loams, 3 to 6 percent slopes, eroded
Rm	Richfield silt loam, 0 to 1 percent slopes
Rn	Richfield silt loam, 1 to 3 percent slopes
Ro	Richfield-Ulysses silt loams, 1 to 3 percent slopes
Rp	Richfield-Ulysses silt loams, 3 to 6 percent slopes
Rx	Roxbury silt loam
Ts	Tivoli loamy fine sand
Ua	Ulysses silt loam, 0 to 1 percent slopes
Ub	Ulysses silt loam, 1 to 3 percent slopes
Uc	Ulysses silt loam, 3 to 6 percent slopes
Ud	Ulysses silt loam, 6 to 15 percent slopes
Ue	Ulysses-Colby silt loams, 1 to 3 percent slopes, eroded
Um	Ulysses-Colby silt loams, 3 to 6 percent slopes, eroded
Un	Ulysses-Colby silt loams, 6 to 15 percent slopes, eroded

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

- Highways and roads
  - Dual
  - Good motor
  - Poor motor
  - Trail
- Highway markers
  - National Interstate
  - U. S.
  - State or county
- Railroads
  - Single track
  - Multiple track
  - Abandoned
- Bridges and crossings
  - Road
  - Trail
  - Railroad
  - Ferry (FY)
  - Ford (FORD)
  - Grade
  - R. R. over
  - R. R. under
- Tunnel
- Buildings
  - School
  - Church
- Mine and quarry
- Gravel pit
- Power line
- Pipeline
- Cemetery
- Dams
- Levee
- Tanks
- Well, oil or gas
- Forest fire or lookout station
- Windmill

BOUNDARIES

- National or state
- County
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

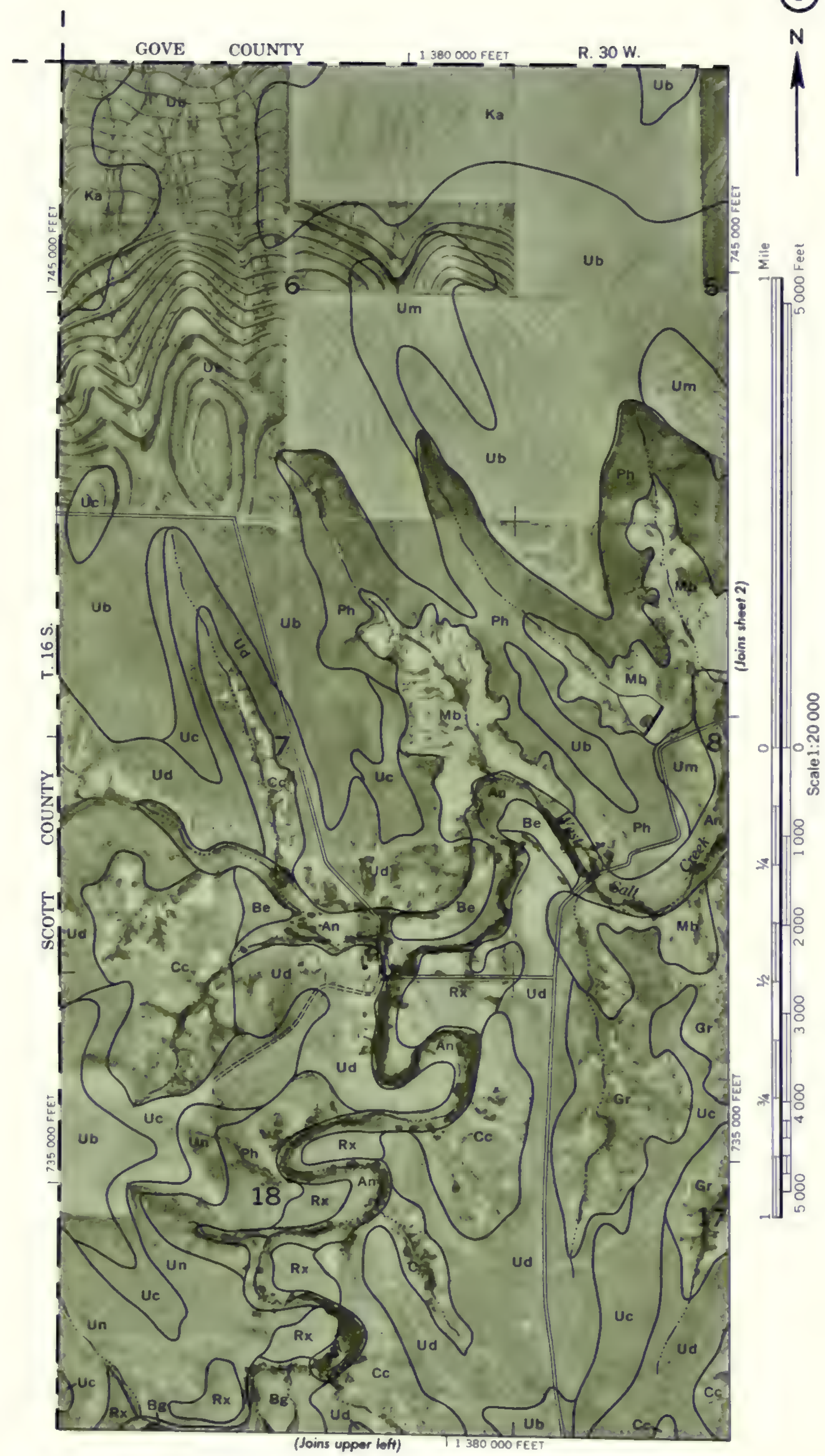
- Streams, double-line
  - Perennial
  - Intermittent
- Streams, single-line
  - Perennial
  - Intermittent
    - Crossable with tillage implements
    - Not crossable with tillage implements
  - Unclassified
- Canals and ditches (CANAL)
- Lakes and ponds
  - Perennial (water, w)
  - Intermittent (int)
- Spring
- Marsh or swamp
- Wet spot
- Alluvial fan
- Drainage end

RELIEF

- Escarpments
  - Bedrock
  - Other
- Prominent peak
- Depressions (Large, Small)
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Contains water most of the time

SOIL SURVEY DATA

- Soil boundary and symbol (Dx)
- Gravel
- Stoniness
  - Stony
  - Very stony
- Rock outcrops
- Chert fragments
- Clay spot
- Sand spot
- Gumbo or scabby spot
- Made land
- Severely eroded spot
- Blowout, wind erosion
- Gully



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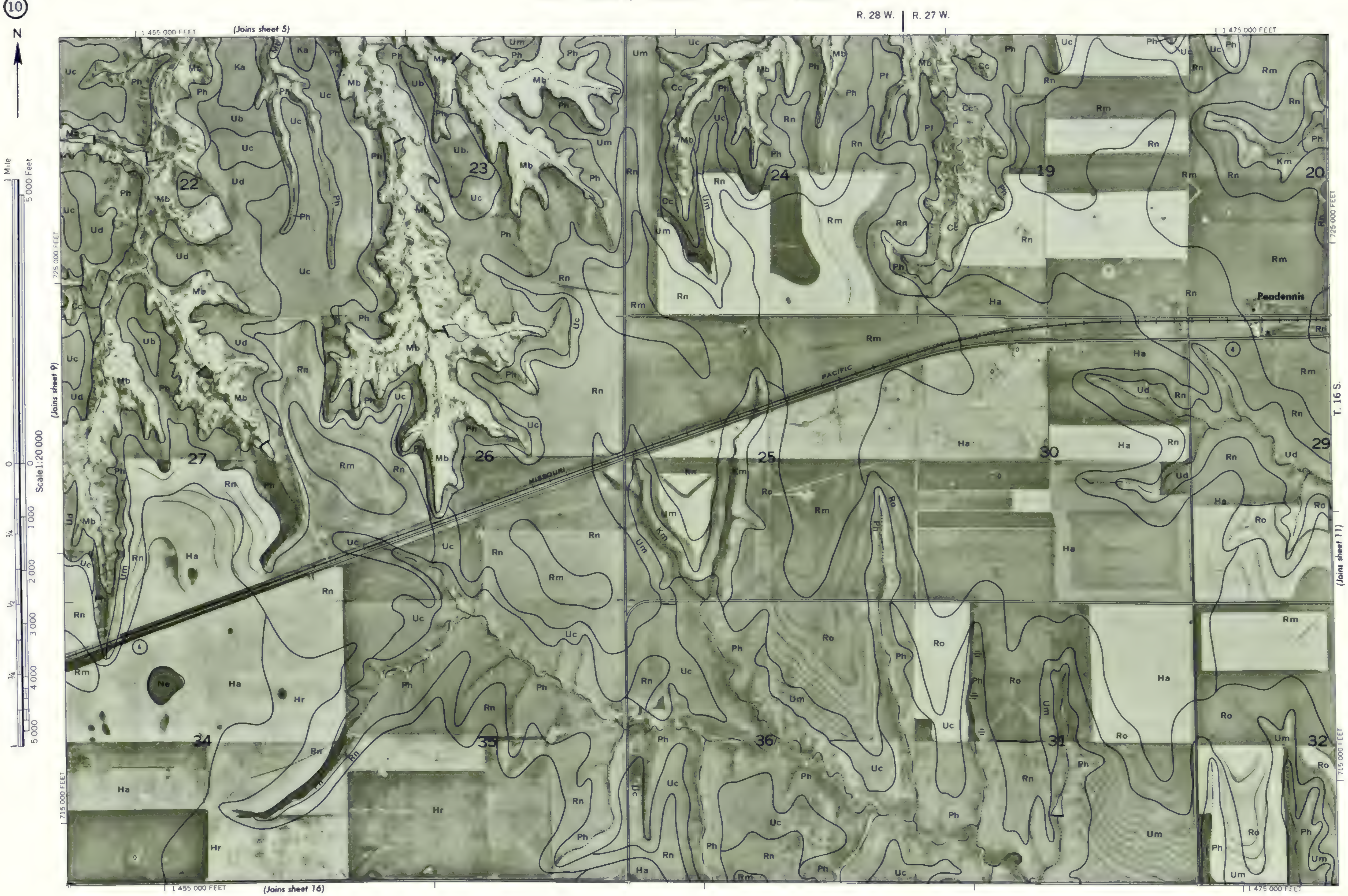
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum
Land division corners are approximately positioned on this map.
LANE COUNTY, KANSAS NO. 1

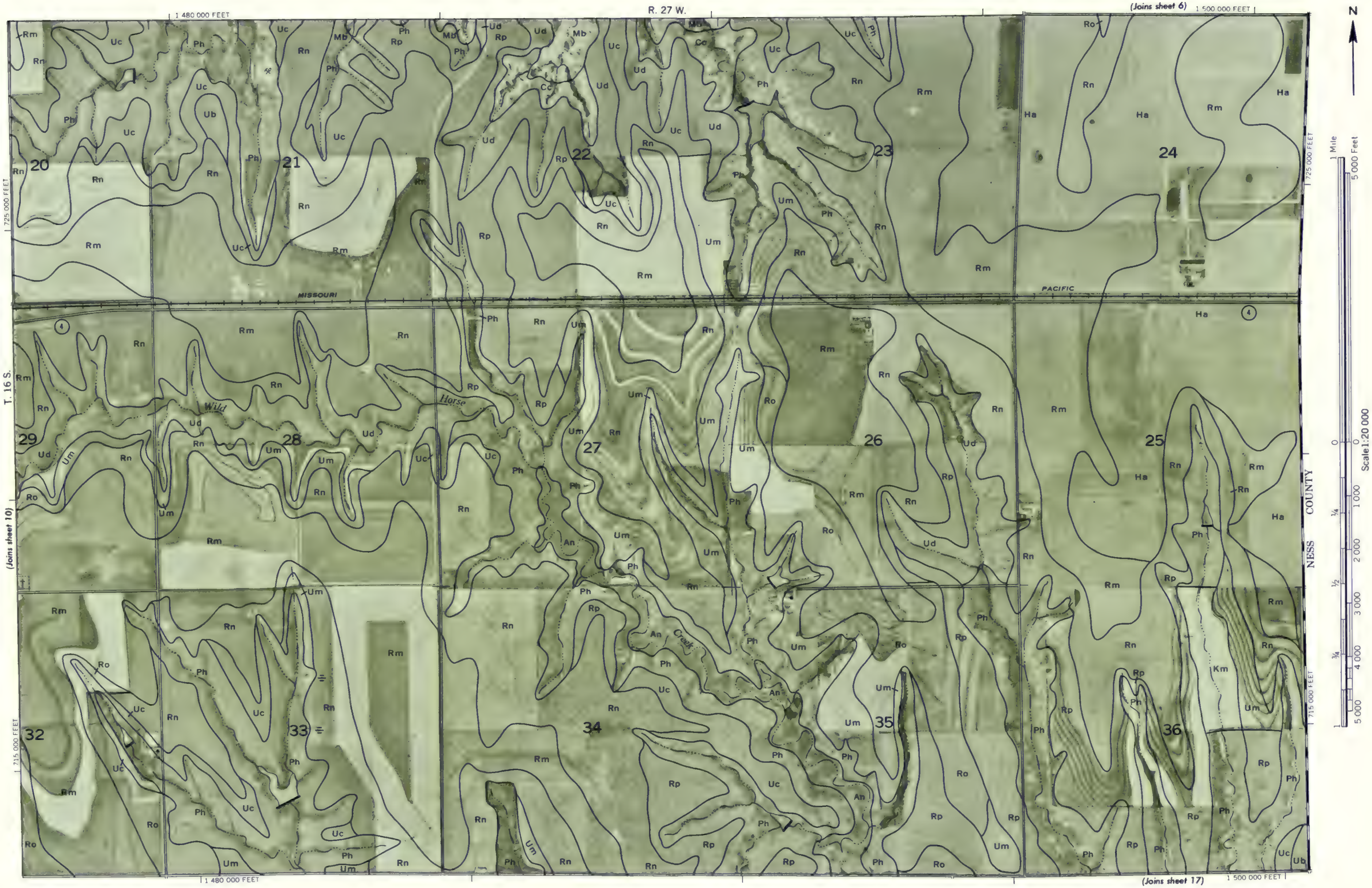
LANE COUNTY, KANSAS — SHEET NUMBER 10



LANE COUNTY, KANSAS NO. 10

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

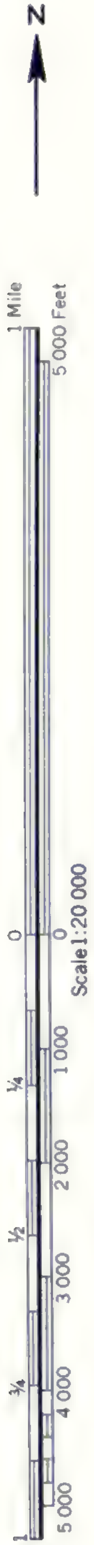
LANE COUNTY, KANSAS — SHEET NUMBER 11

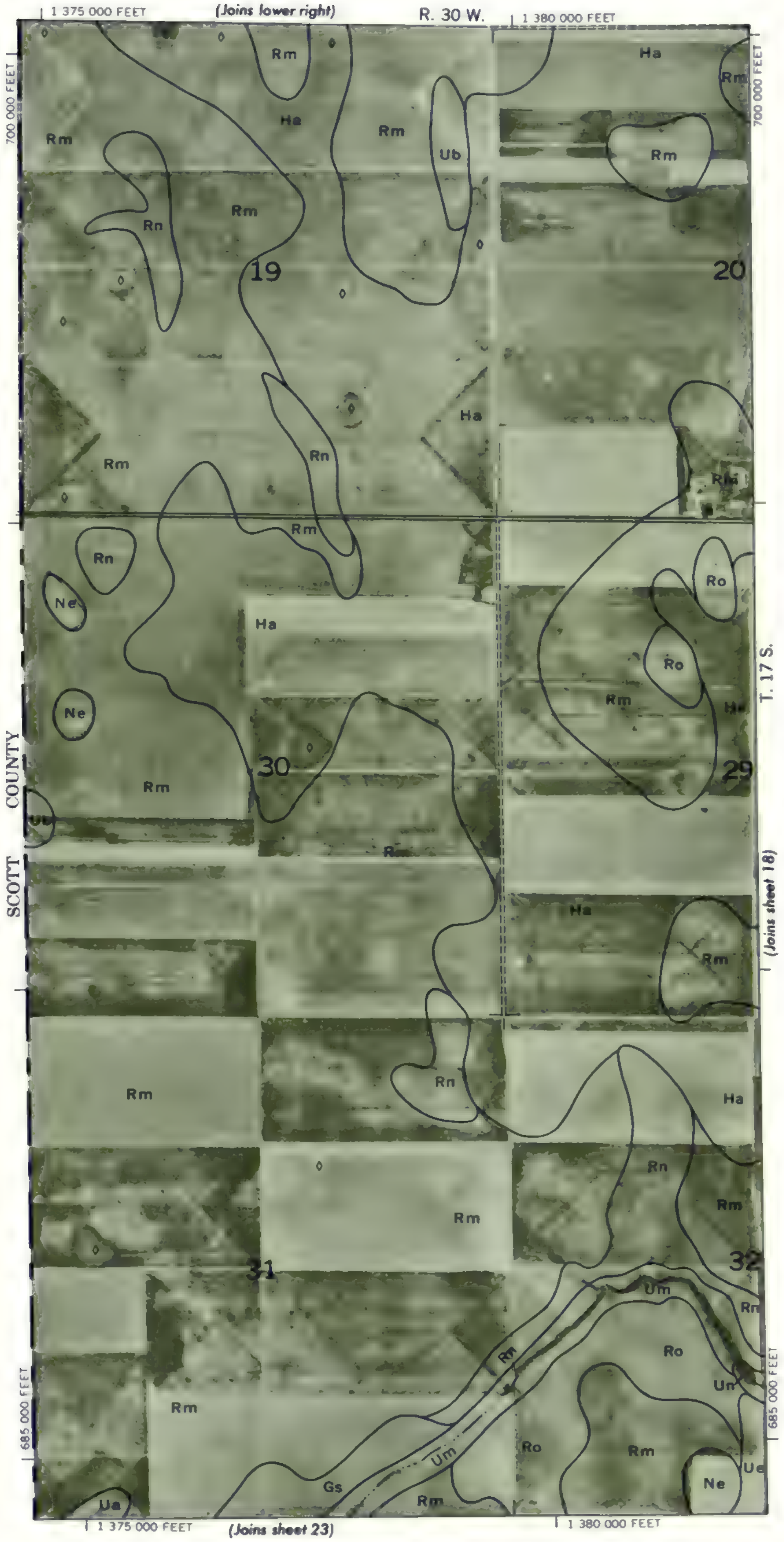


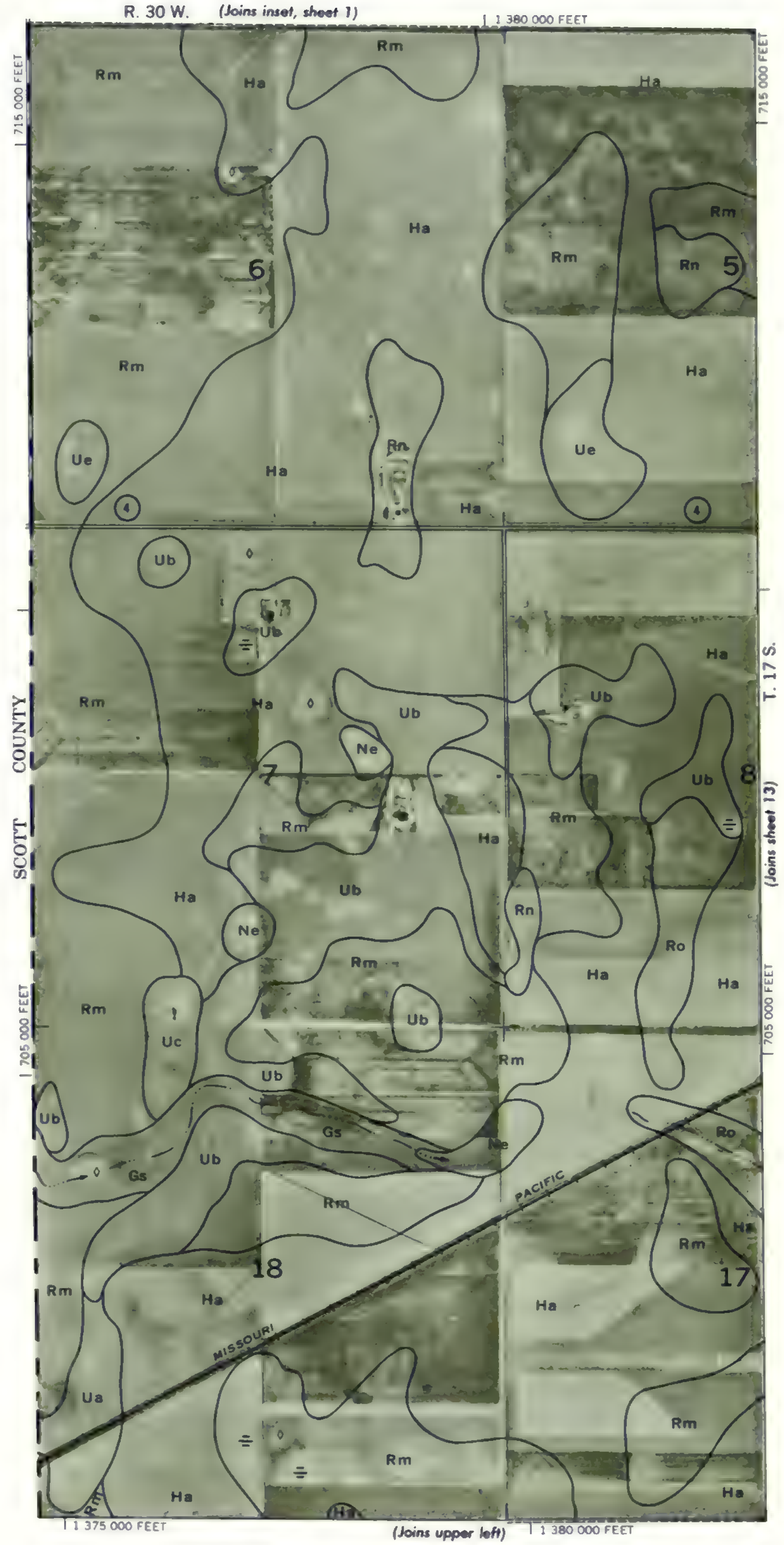
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 11

12







LANE COUNTY, KANSAS NO. 12

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone, 1927 North American datum

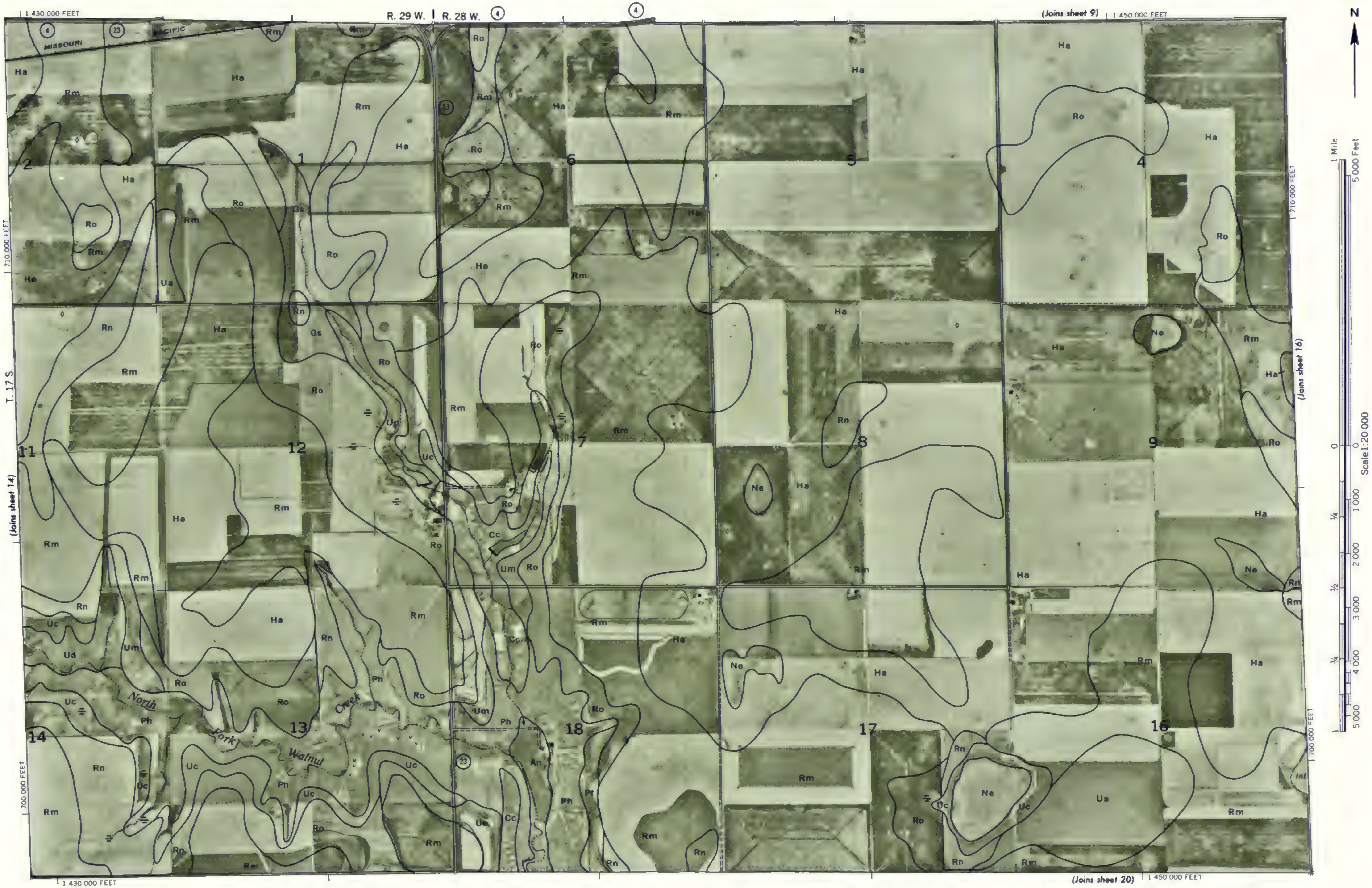
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 13

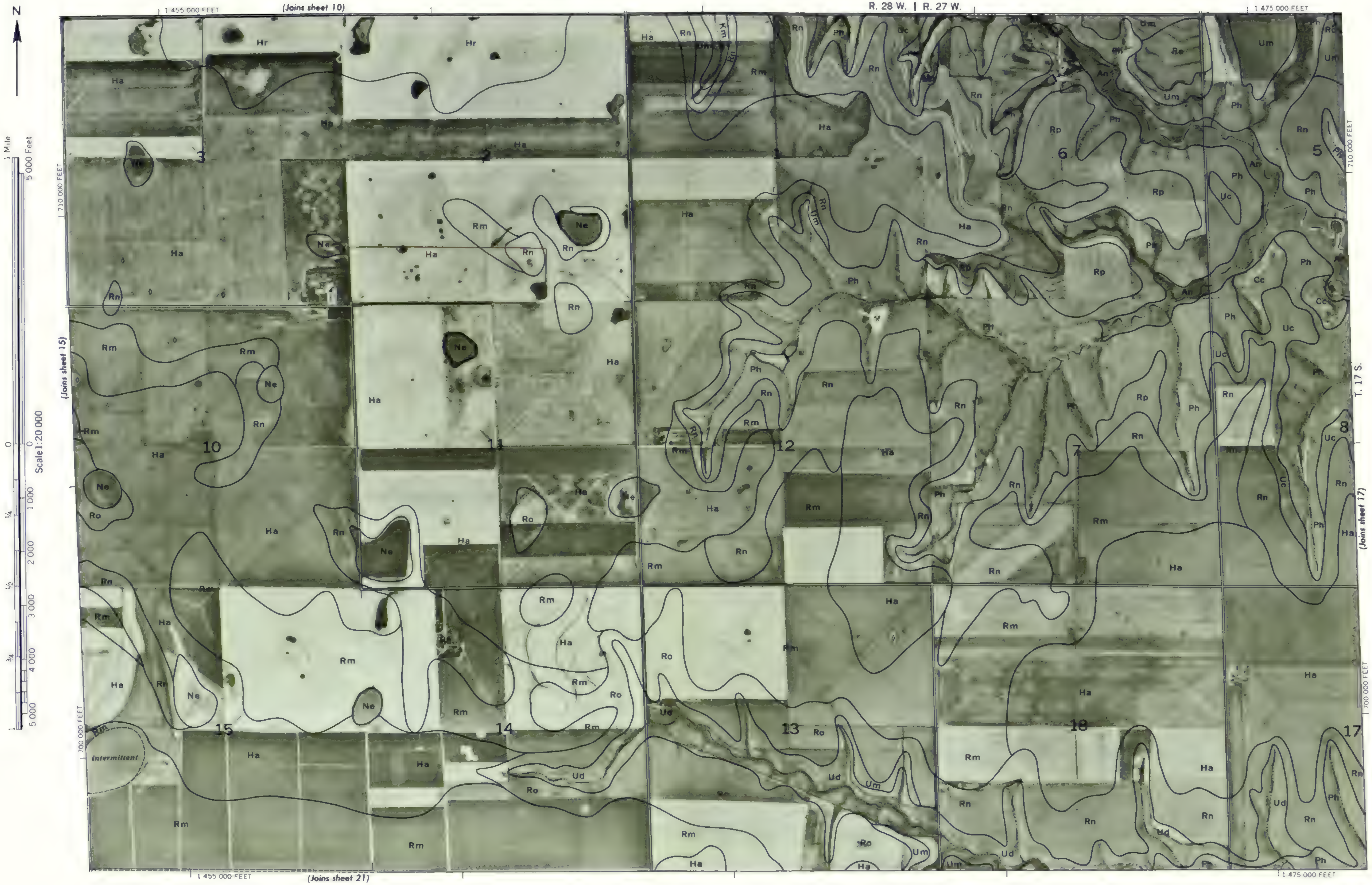
LANE COUNTY, KANSAS — SHEET NUMBER 14

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 14



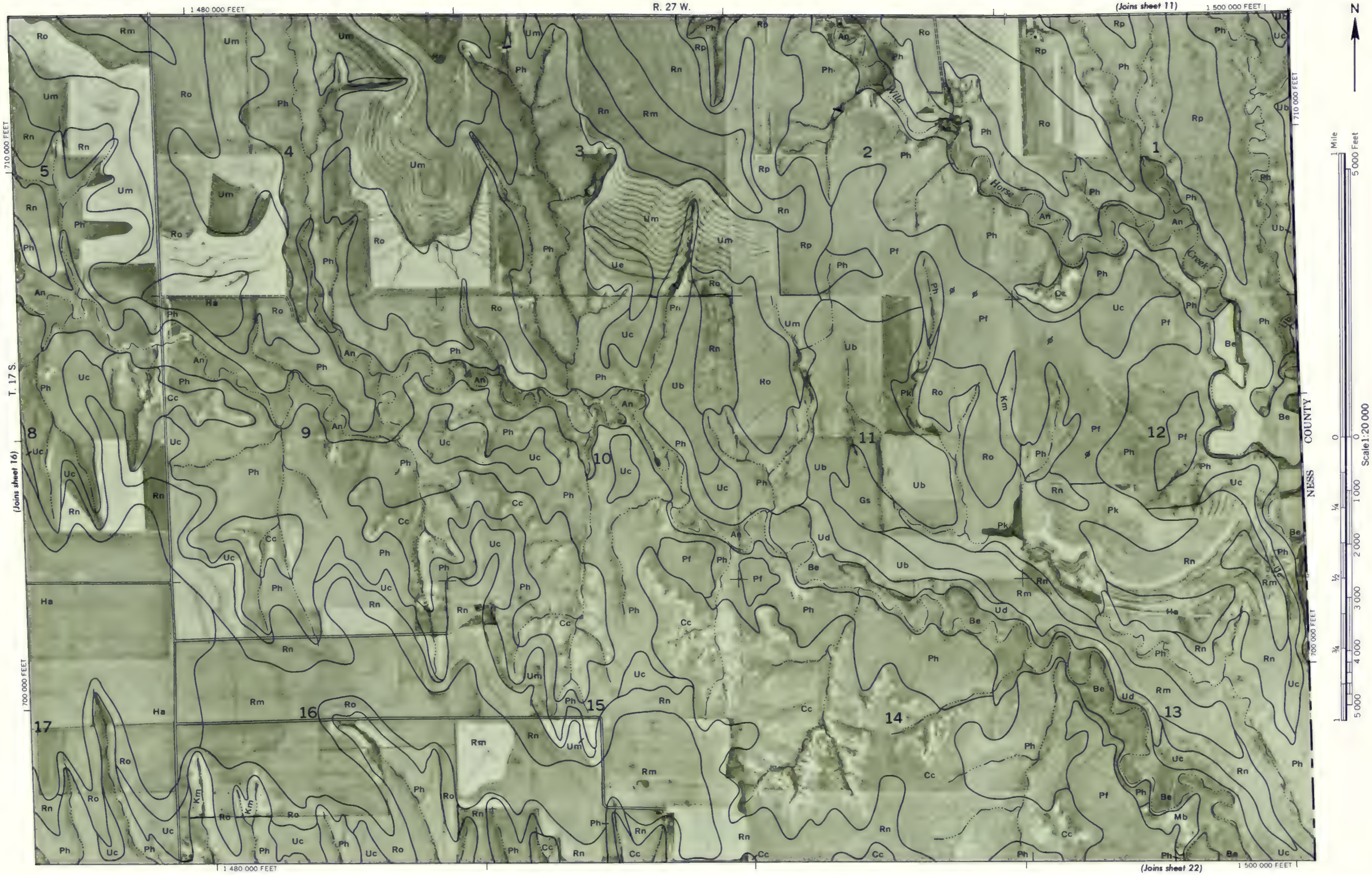
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum
Land division corners are approximately positioned on this map.



LANE COUNTY, KANSAS NO. 16

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

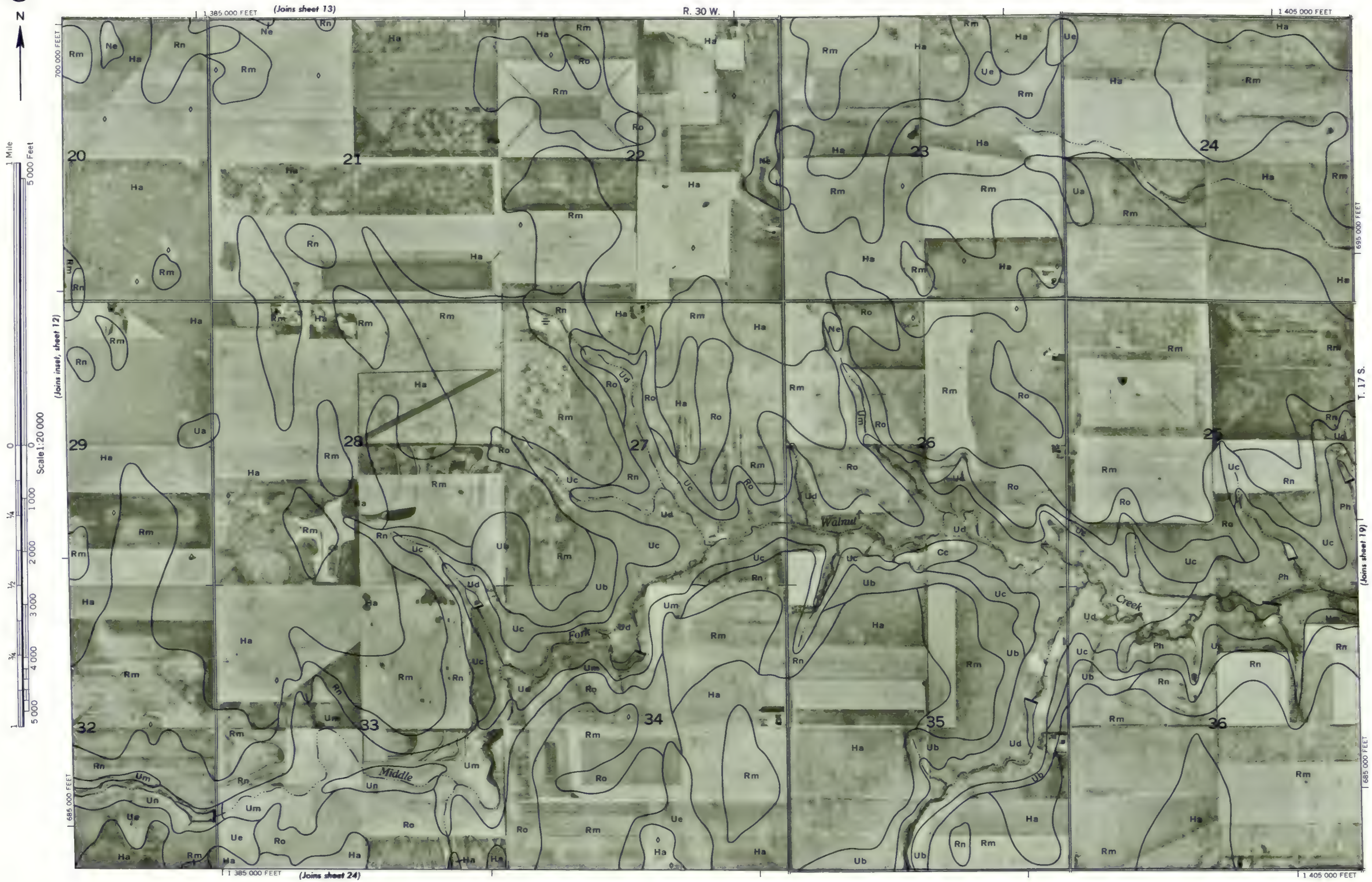
Land division corners are approximately positioned on this map.



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 17

LANE COUNTY, KANSAS — SHEET NUMBER 18



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 19

LANE COUNTY, KANSAS — SHEET NUMBER 2

N

Scale 1:20 000

1 Mile | 0 | 1/4 | 1/2 | 3/4 | 1

5 000 Feet | 0 | 1 000 | 2 000 | 3 000 | 4 000 | 5 000

LANE COUNTY, KANSAS NO. 2

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone, 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS — SHEET NUMBER 20

LANE COUNTY, KANSAS NO. 20

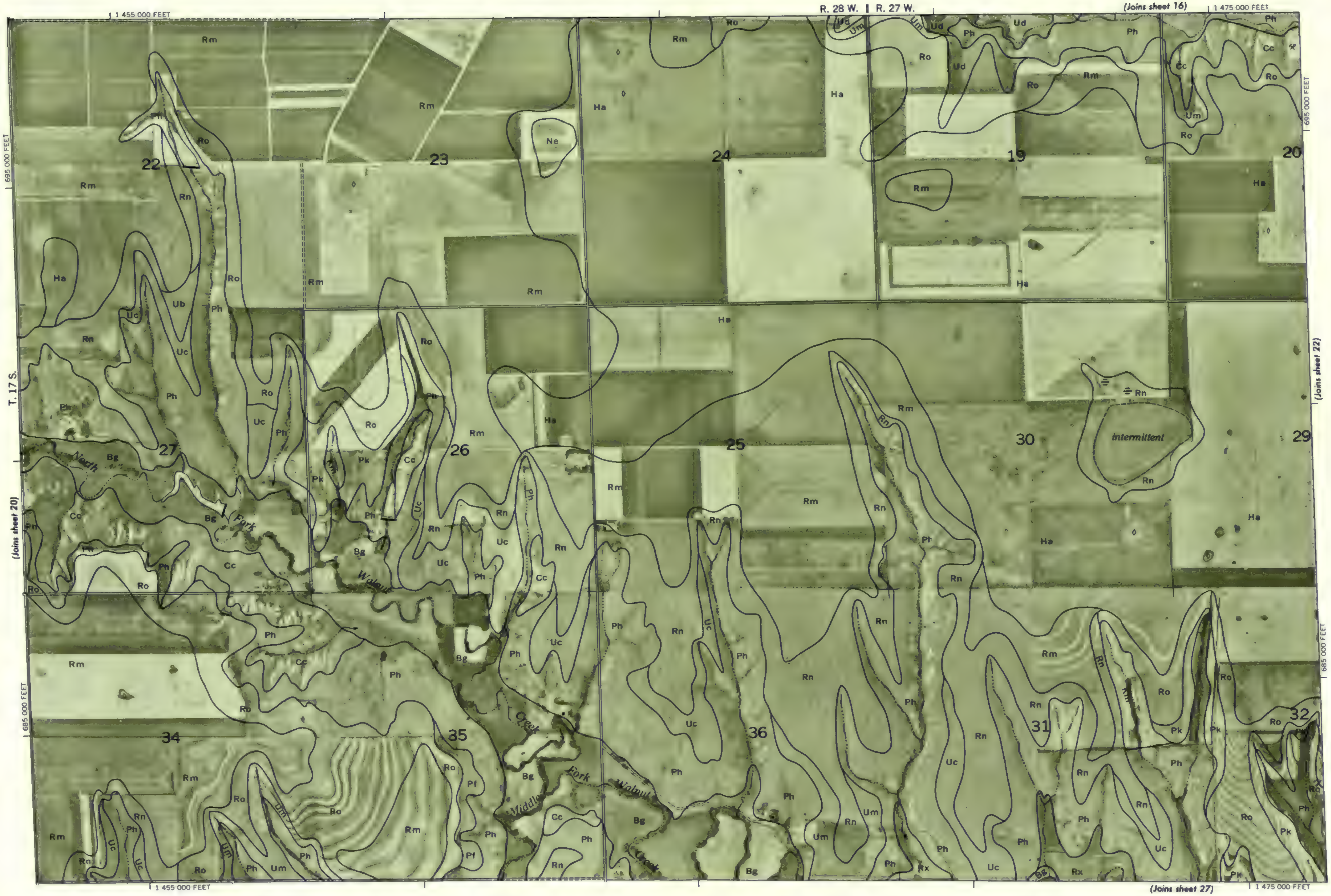
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum

Land division corners are approximately positioned on this map.

N

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 21



1 Mile

5 000 Feet

Scale 1:20 000

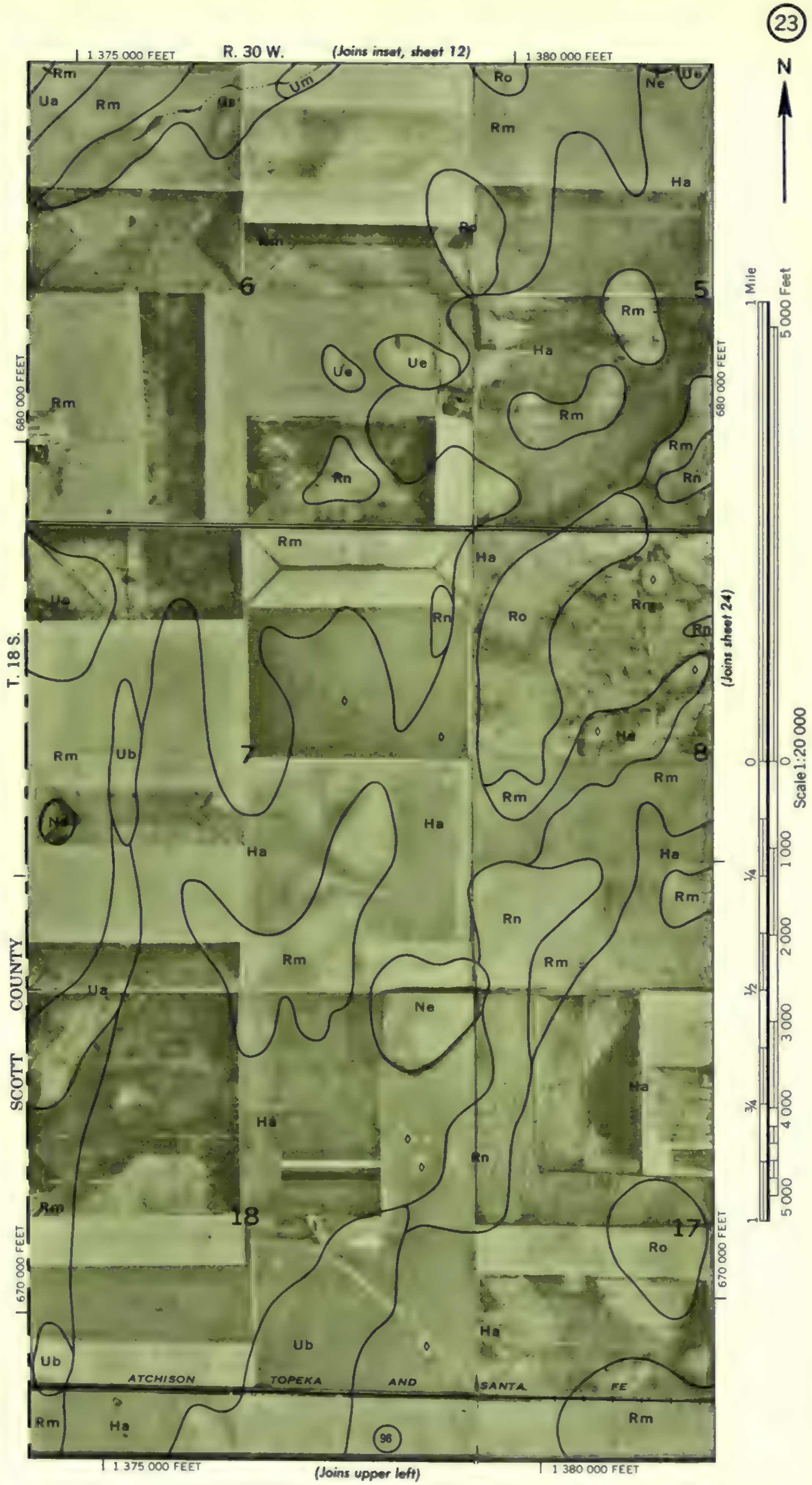
LANE COUNTY, KANSAS — SHEET NUMBER 22

LANE COUNTY, KANSAS NO. 22

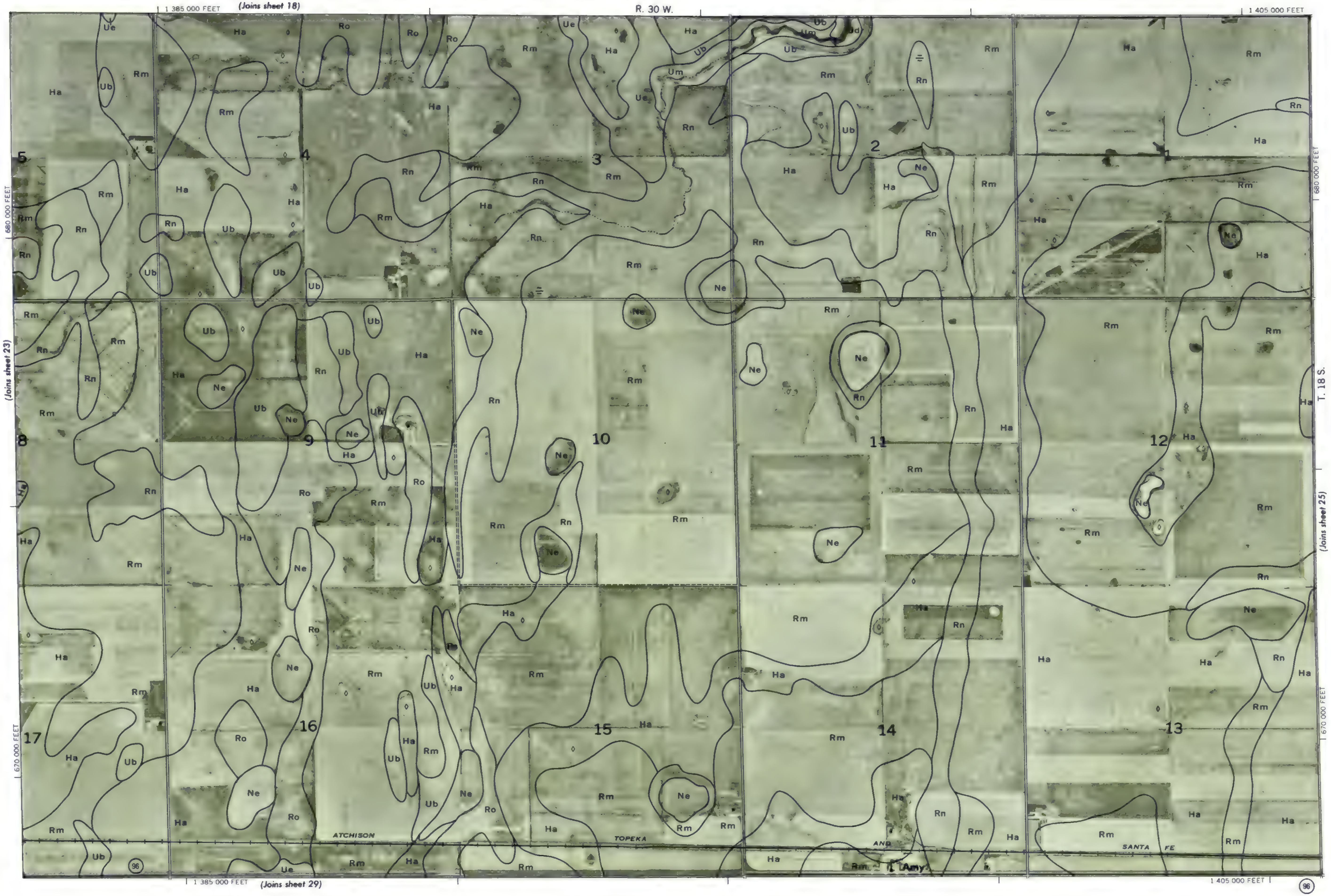
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.
LANE COUNTY, KANSAS NO. 23



24



LANE COUNTY, KANSAS NO. 24

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS — SHEET NUMBER 26

LANE COUNTY, KANSAS NO. 26

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum

Land division corners are approximately positioned on this map

LANE COUNTY, KANSAS — SHEET NUMBER 27

27

N

1 Mile
5 000 Feet
0 0
¼ 1000
2000
½ 3000
4000
¾
5000
1 5000
Scale 1:20 000

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 27

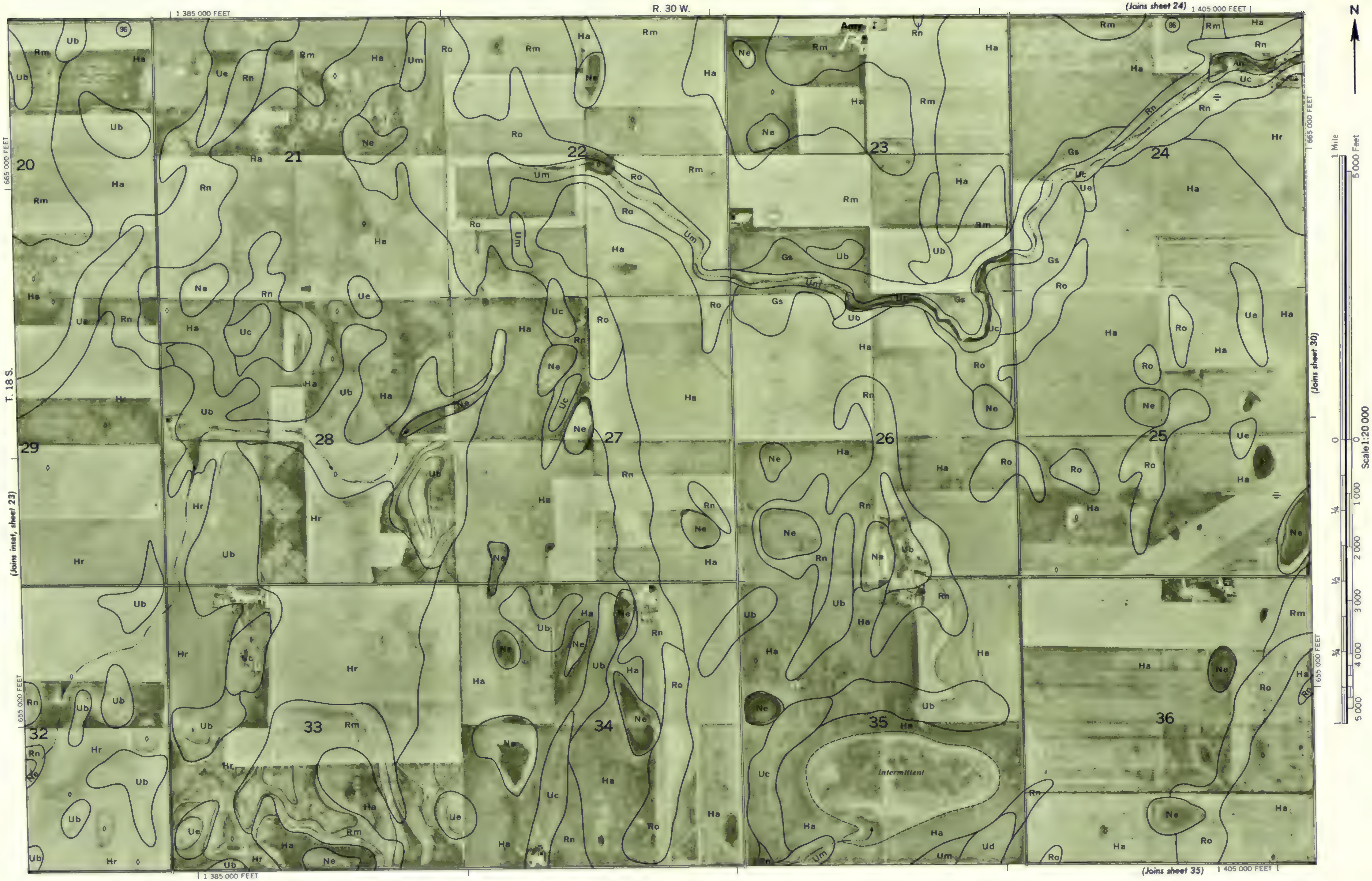
LANE COUNTY, KANSAS — SHEET NUMBER 28

LANE COUNTY, KANSAS NO. 28

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone, 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS — SHEET NUMBER 29

29



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 29

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000 foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 3

LANE COUNTY, KANSAS — SHEET NUMBER 30

LANE COUNTY, KANSAS NO. 30

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 31

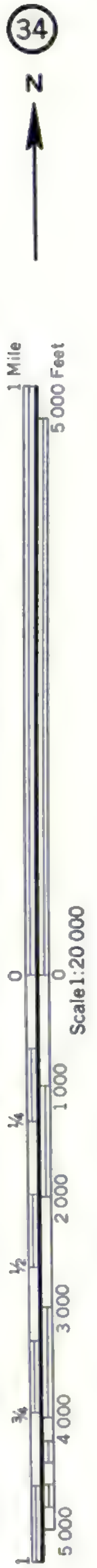
LANE COUNTY, KANSAS — SHEET NUMBER 32

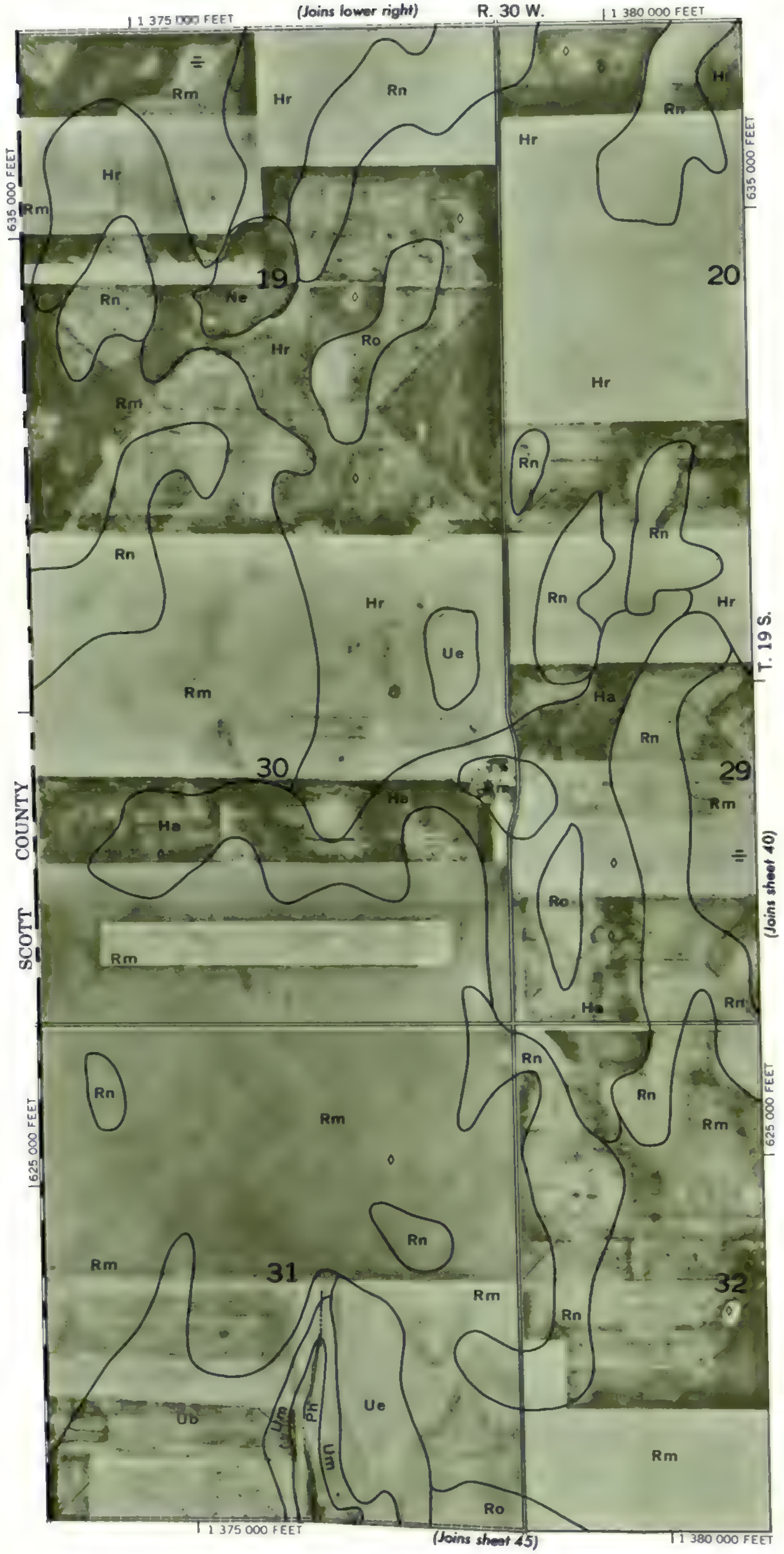
LANE COUNTY, KANSAS NO. 32

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.





LANE COUNTY, KANSAS NO. 34

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 35

LANE COUNTY, KANSAS — SHEET NUMBER 36

LANE COUNTY, KANSAS NO. 36

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Purdue University Agricultural Experiment Station.
Land division corners are approximately positioned on this map.
Photobase from 1965 aerial photography. Positions of 5,000-foot grid ticks are approximate and based on the Indiana coordinate system west zone

LAKE COUNTY, INDIANA NO. 37

LANE COUNTY, KANSAS — SHEET NUMBER 38

LANE COUNTY, KANSAS NO. 38

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

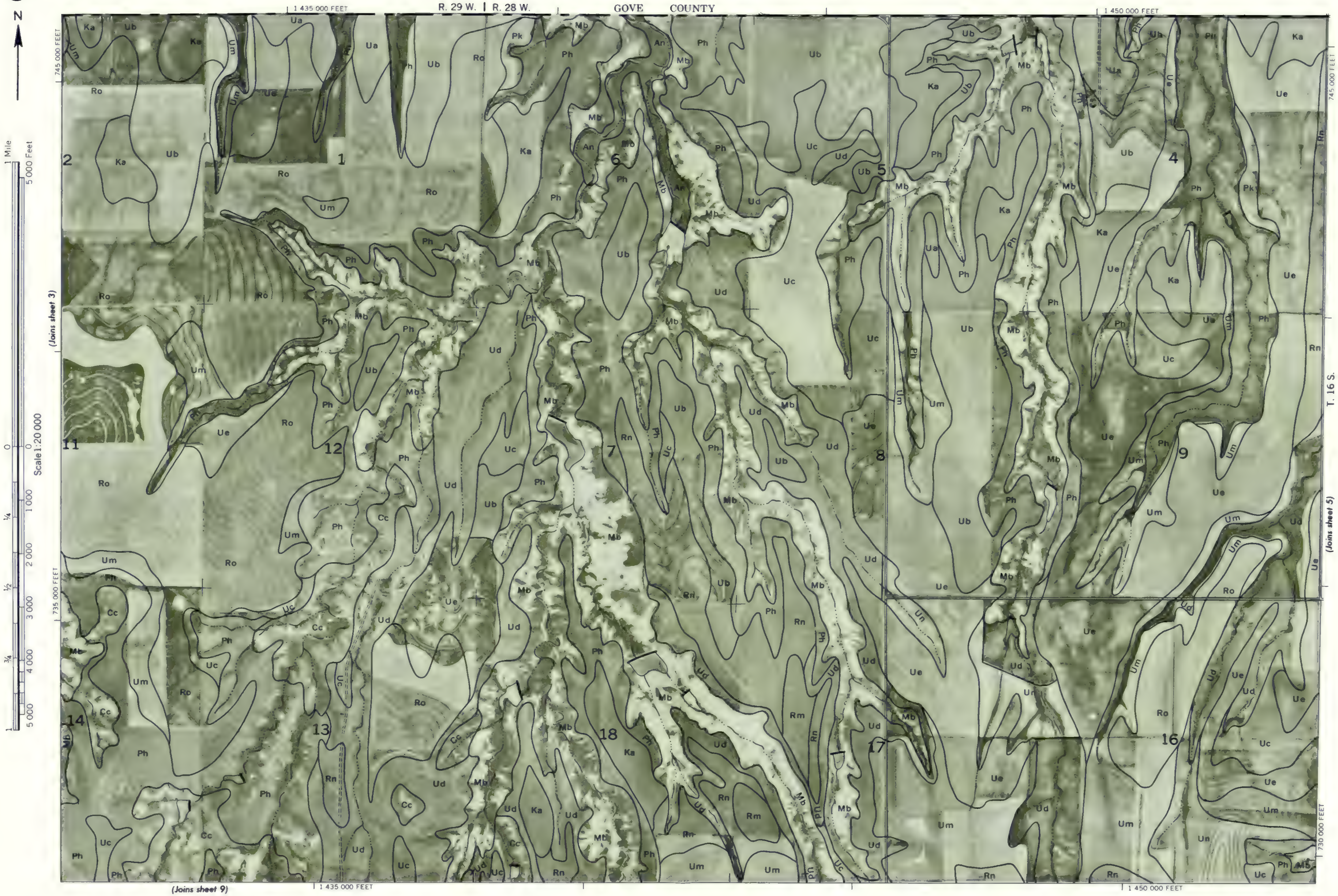
his map is one of a s : compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 39

LANE COUNTY, KANSAS — SHEET NUMBER 4



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station

Photobase from 1965 aerial photographs. 5,000 foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum

Land division corners are approximately positioned on this map

LANE COUNTY, KANSAS NO. 4

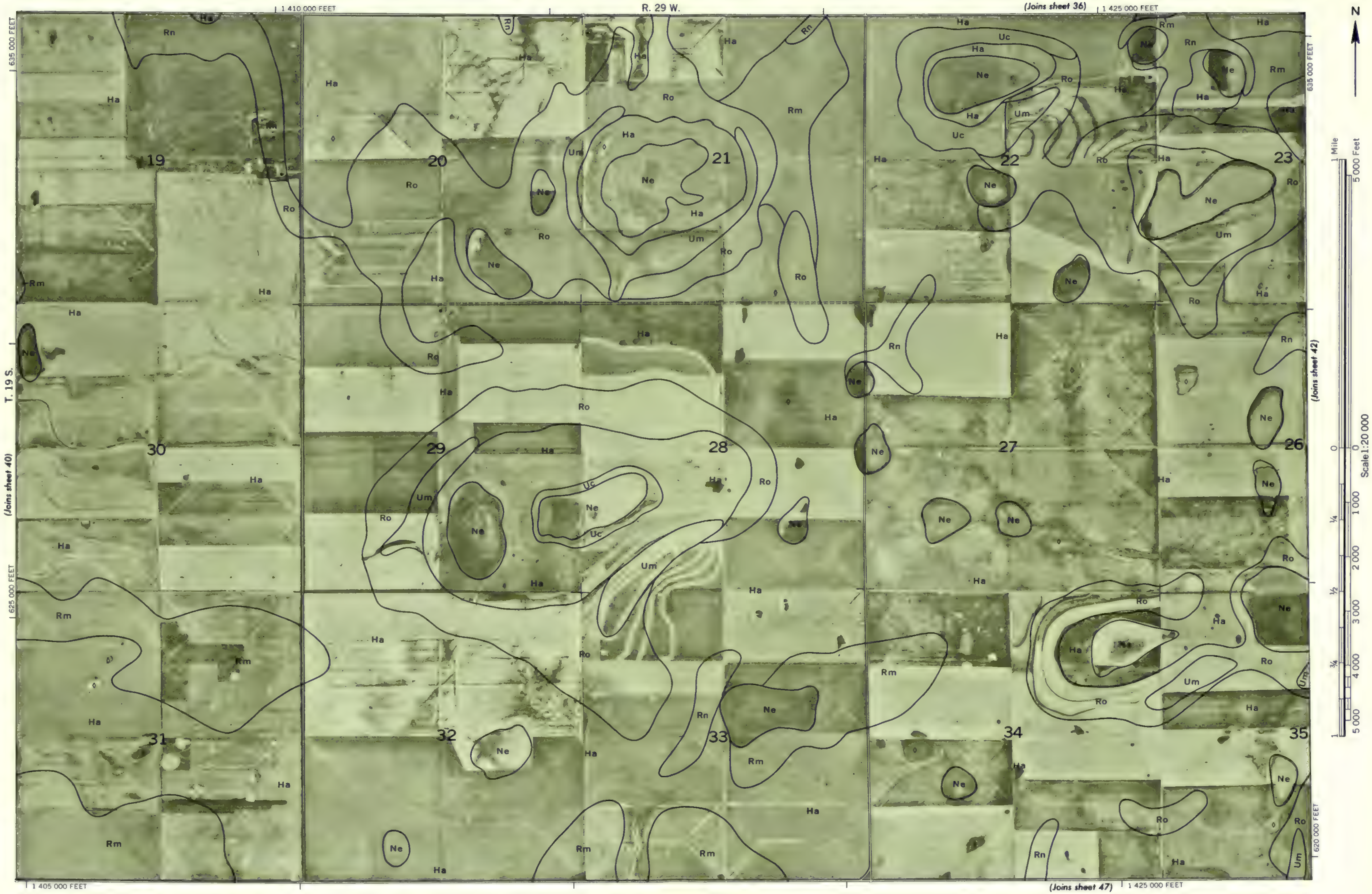
LANE COUNTY, KANSAS — SHEET NUMBER 40

LANE COUNTY, KANSAS NO. 40

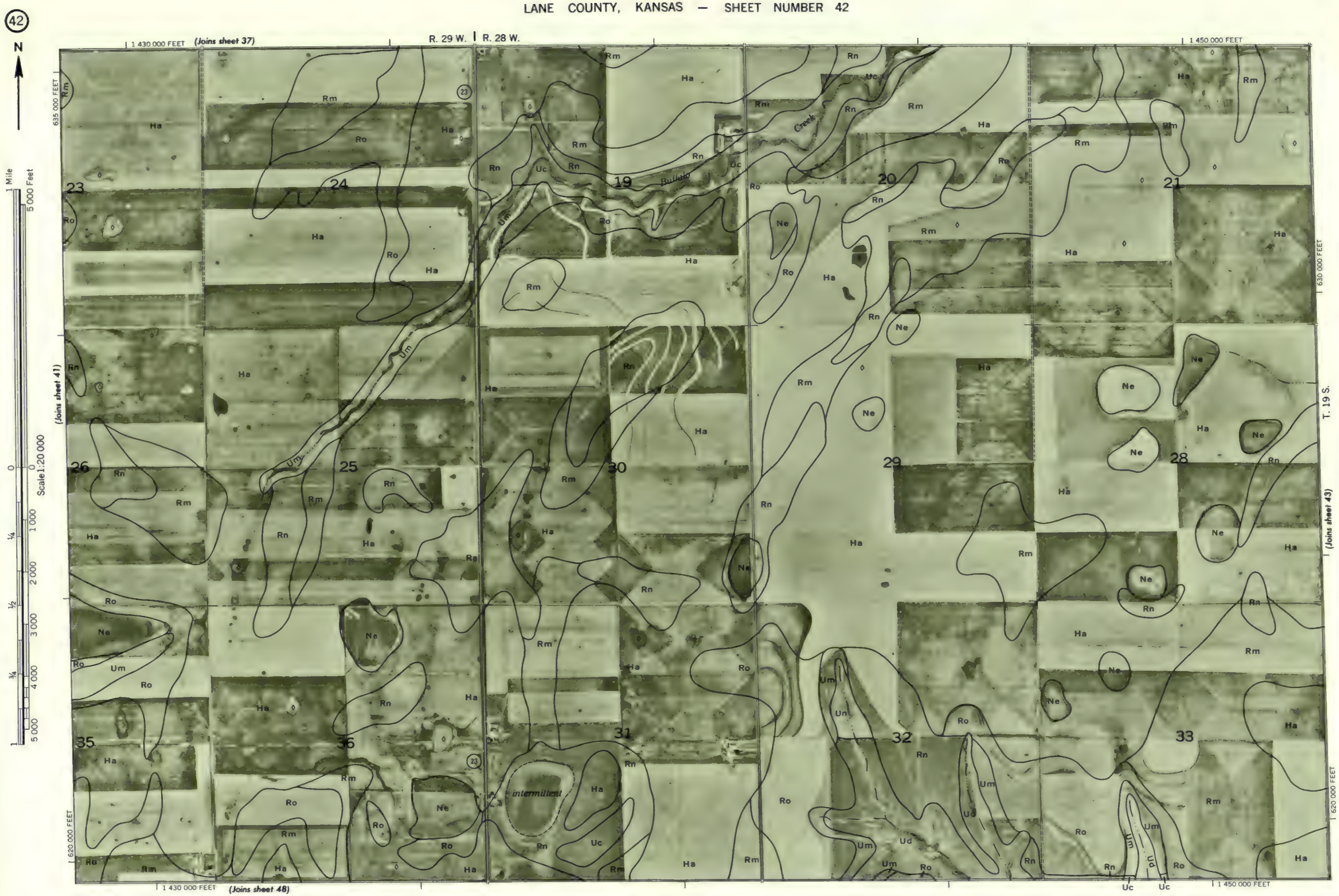
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS — SHEET NUMBER 41



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.
LANE COUNTY, KANSAS NO. 41



LANE COUNTY, KANSAS NO. 42

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

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Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 43

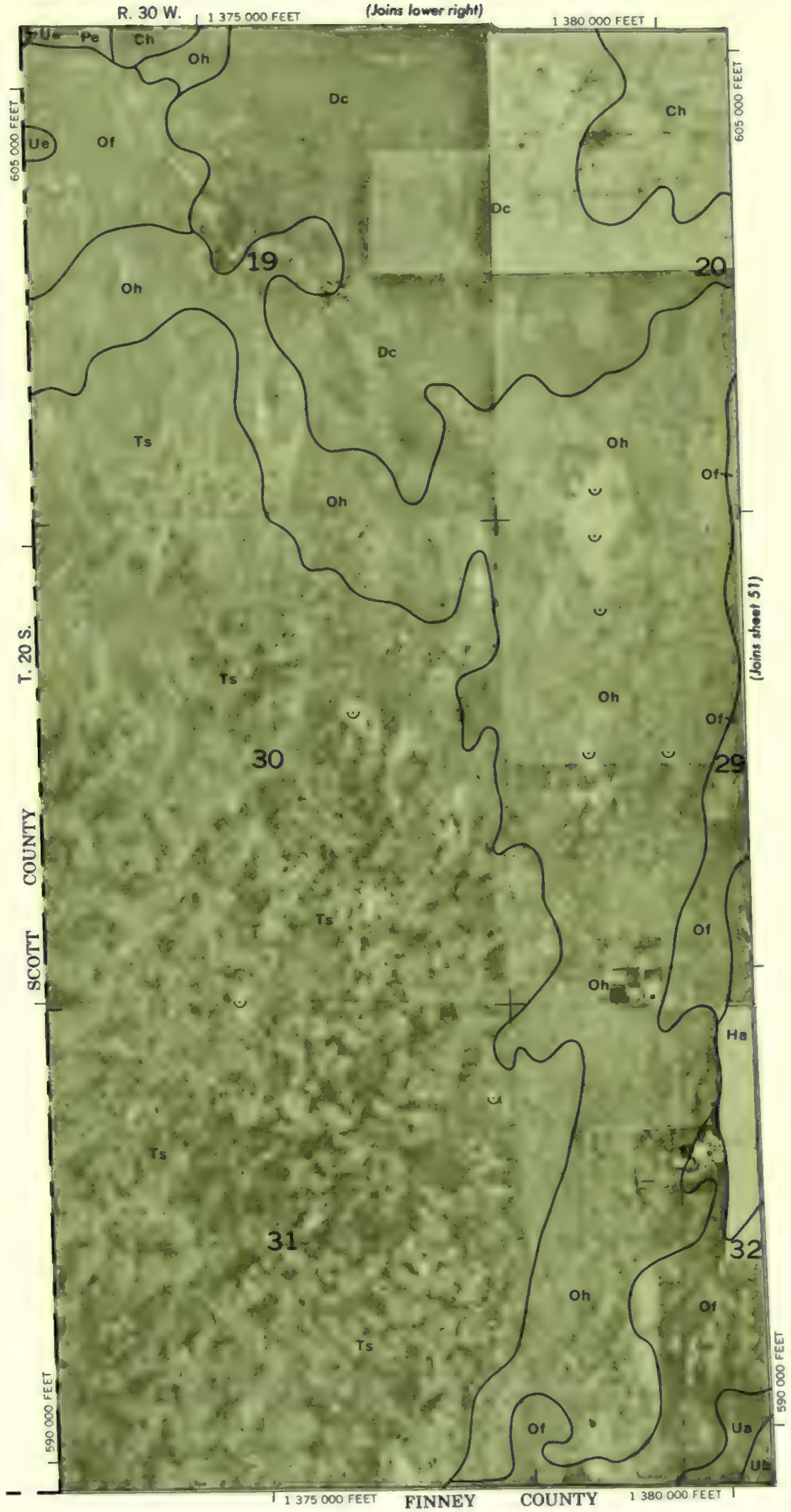
44

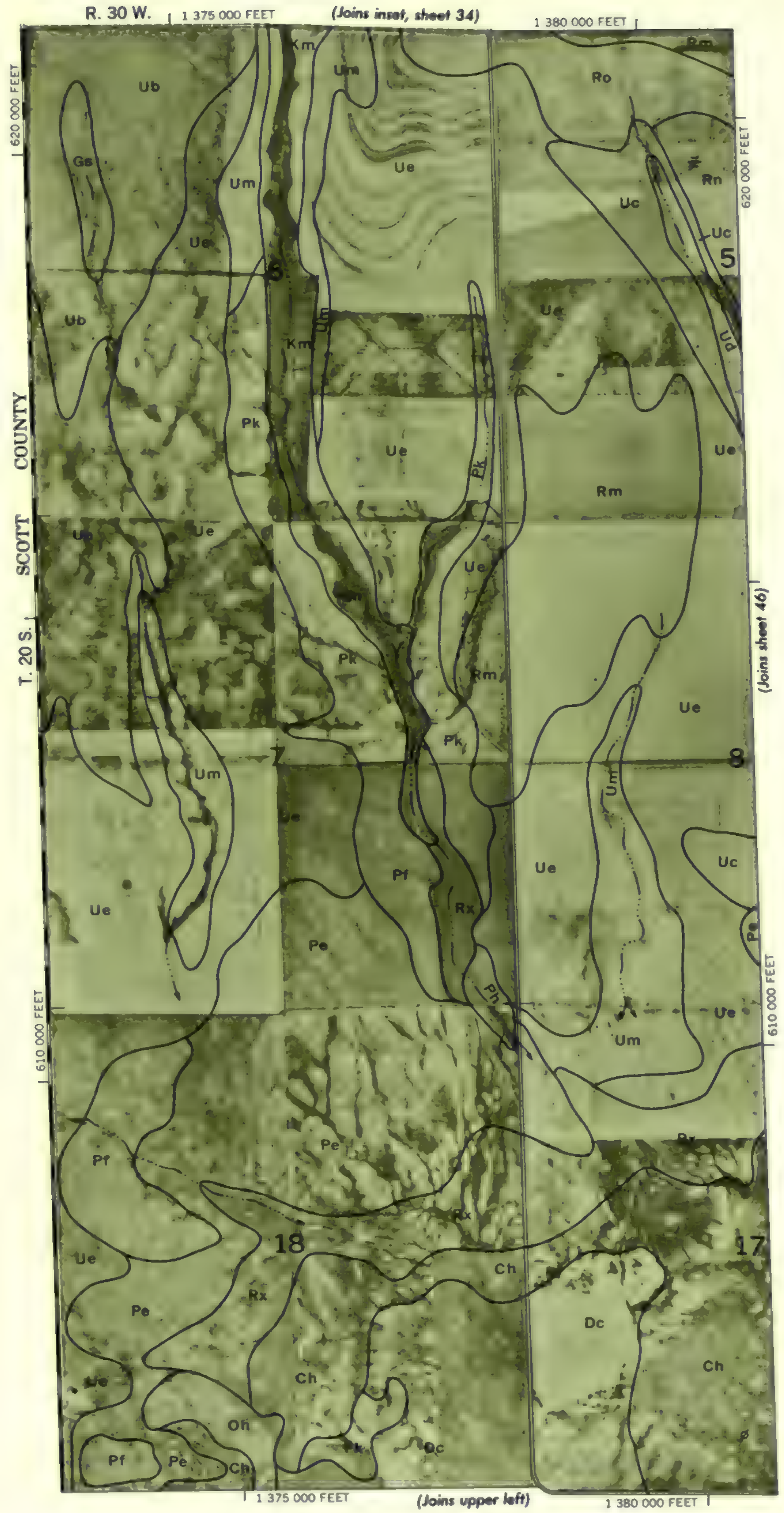
LANE COUNTY, KANSAS — SHEET NUMBER 44

LANE COUNTY, KANSAS NO. 44

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

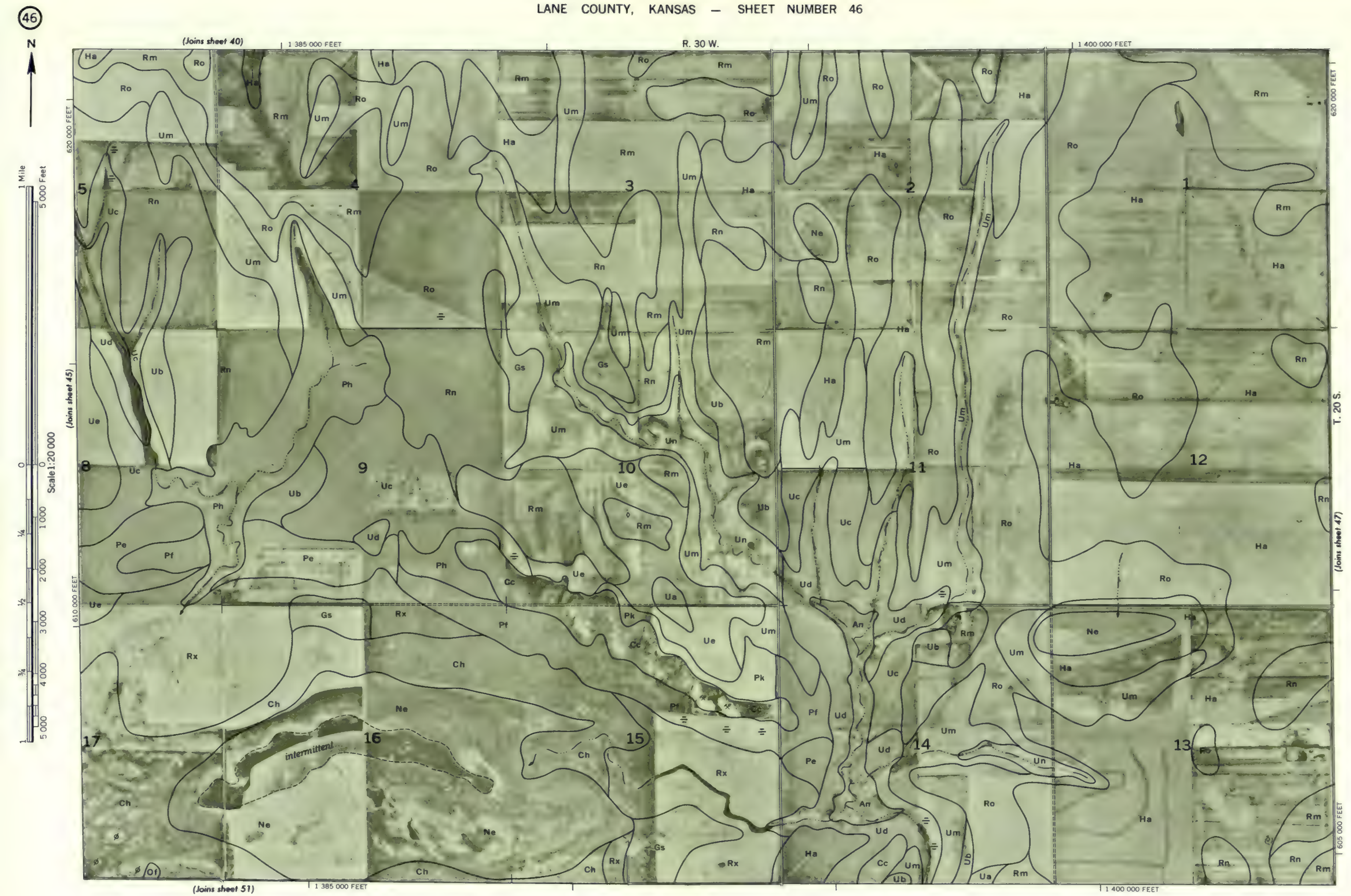
Land division corners are approximately positioned on this map.





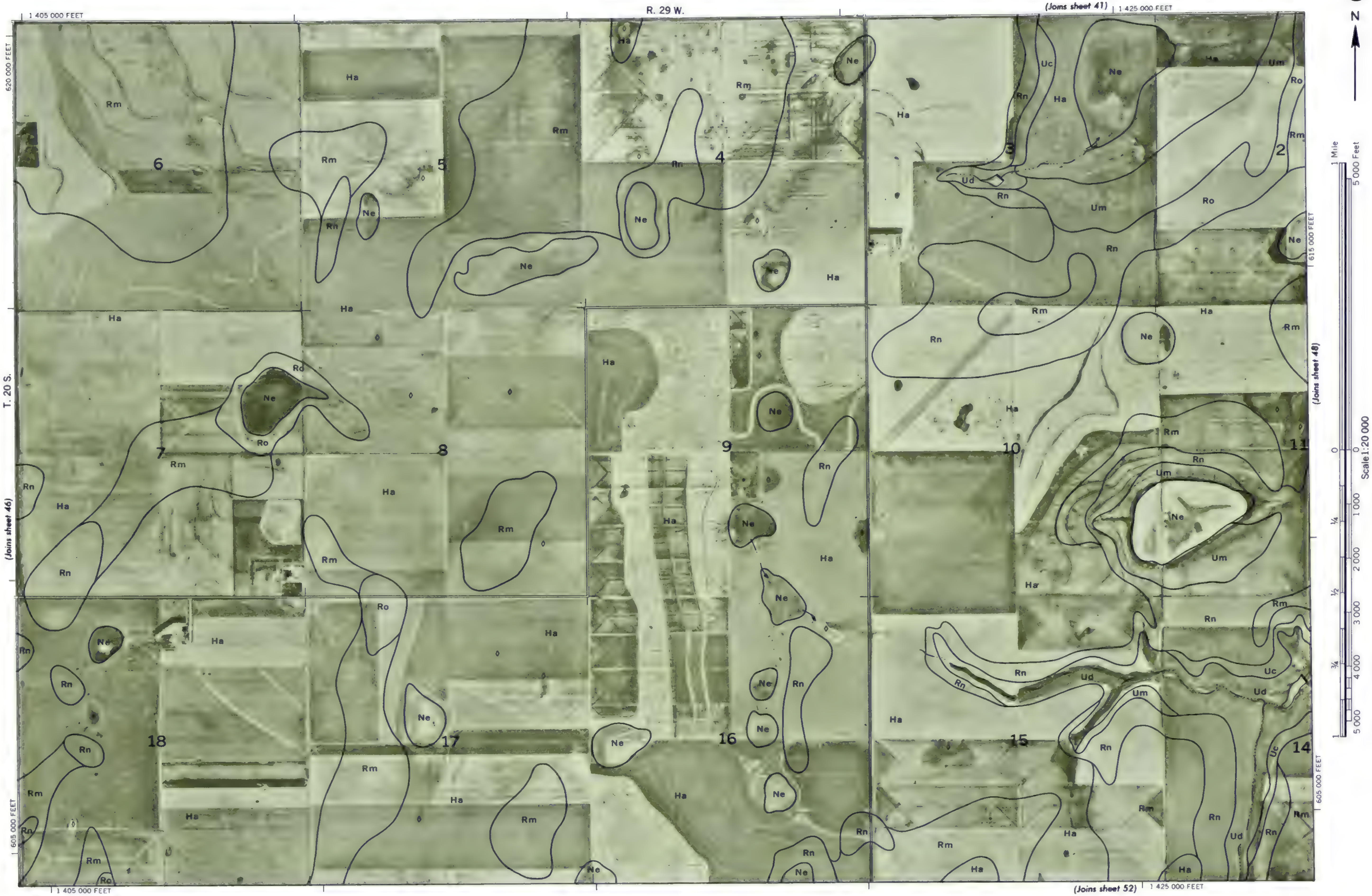
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 45



LANE COUNTY, KANSAS NO. 46

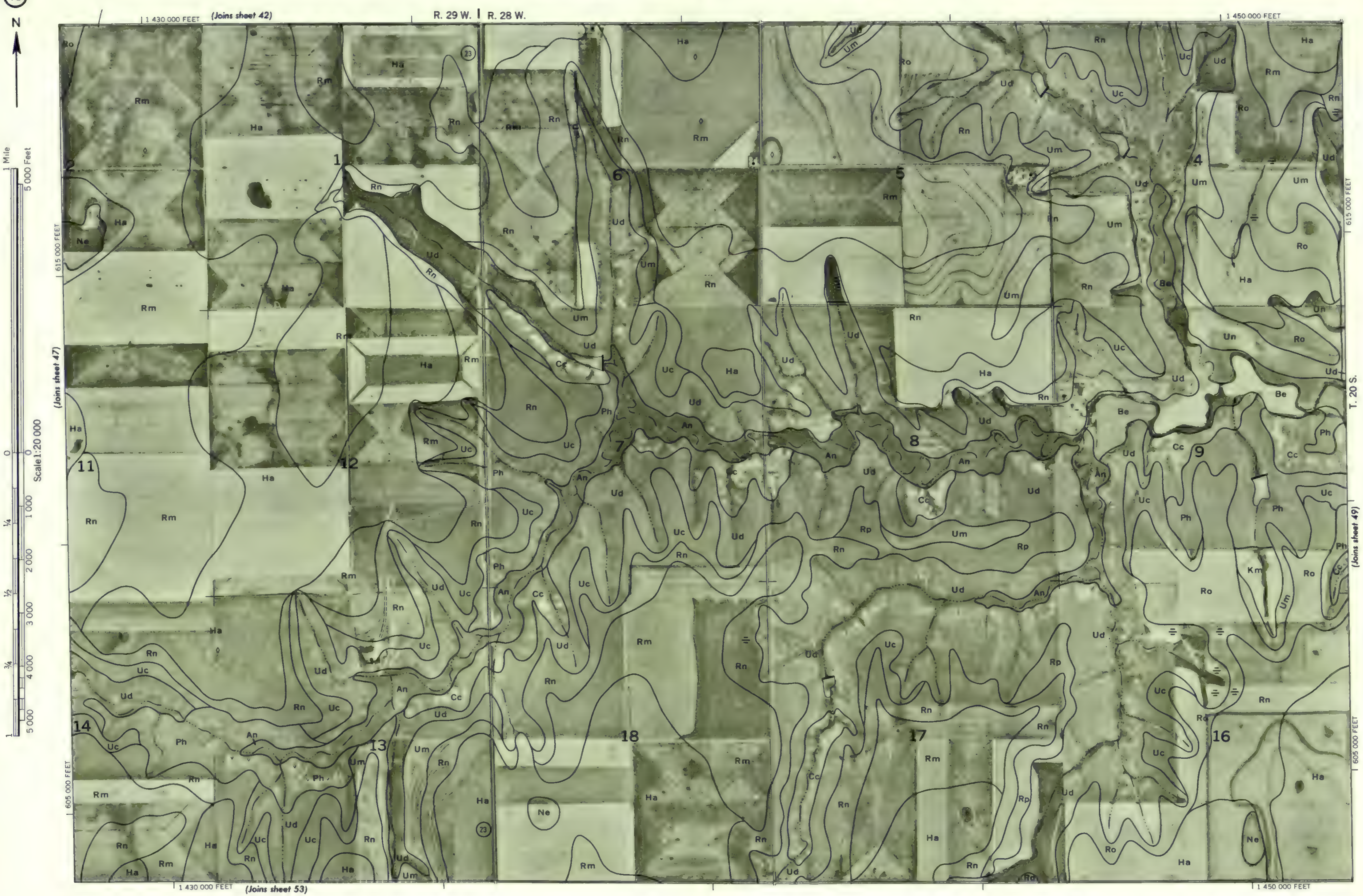
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum
Land division corners are approximately positioned on this map.



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 47

LANE COUNTY, KANSAS — SHEET NUMBER 48



LANE COUNTY, KANSAS NO. 48

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

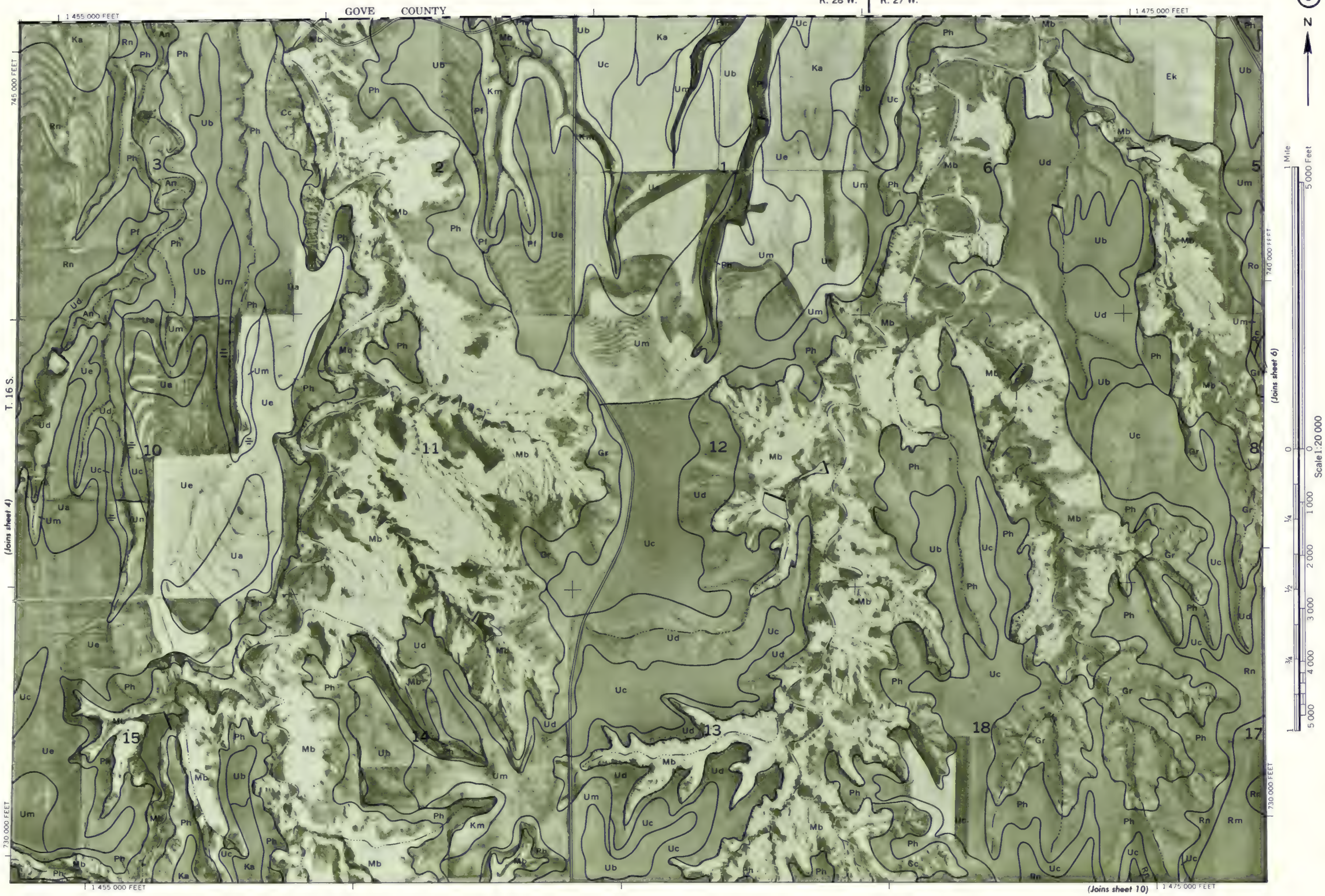
LANE COUNTY, KANSAS — SHEET NUMBER 49

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000 foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 49

LANE COUNTY, KANSAS — SHEET NUMBER 5

5



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.

Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 5

LANE COUNTY, KANSAS NO. 50

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

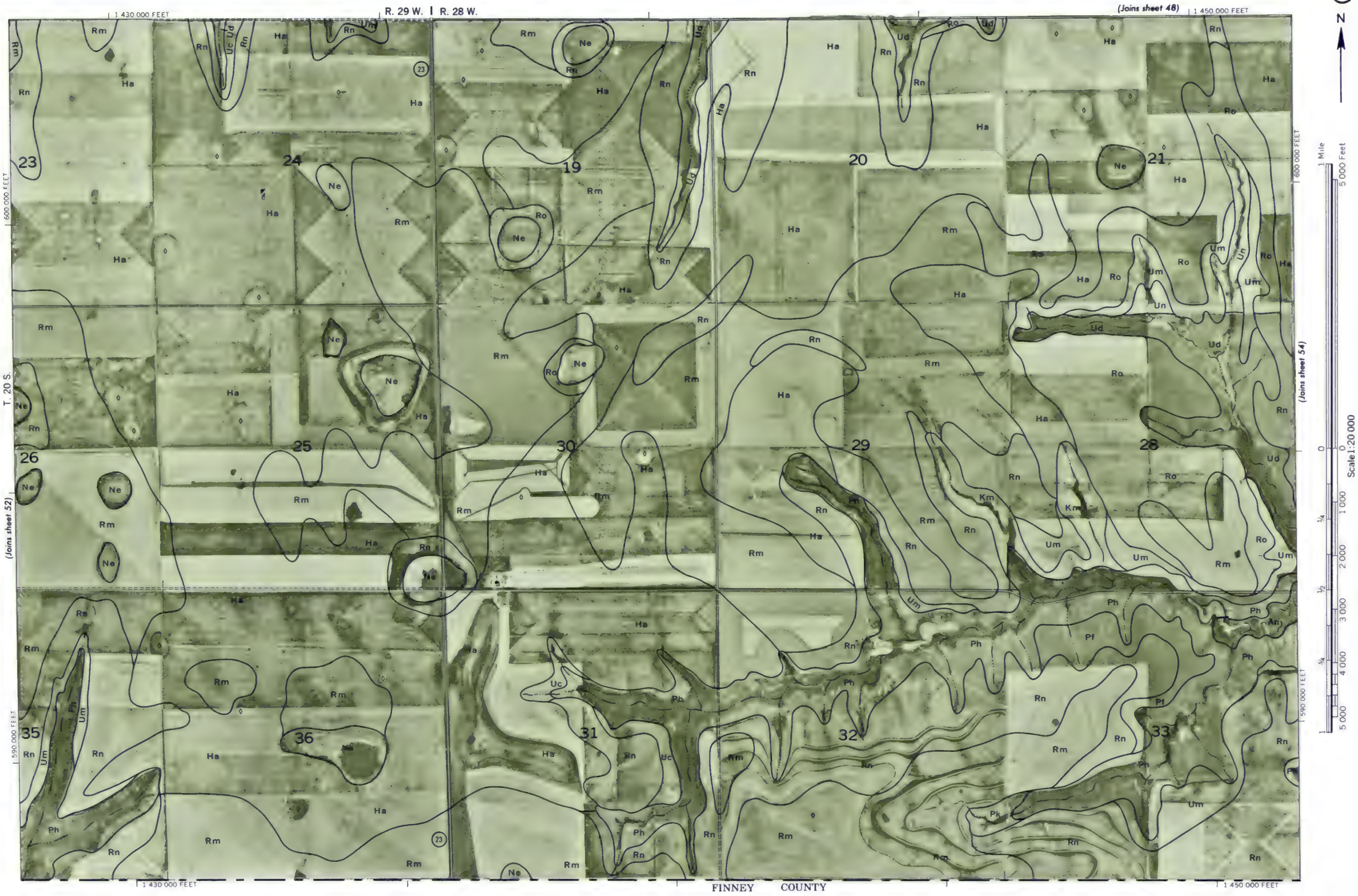
This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 51

LANE COUNTY, KANSAS NO. 52

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

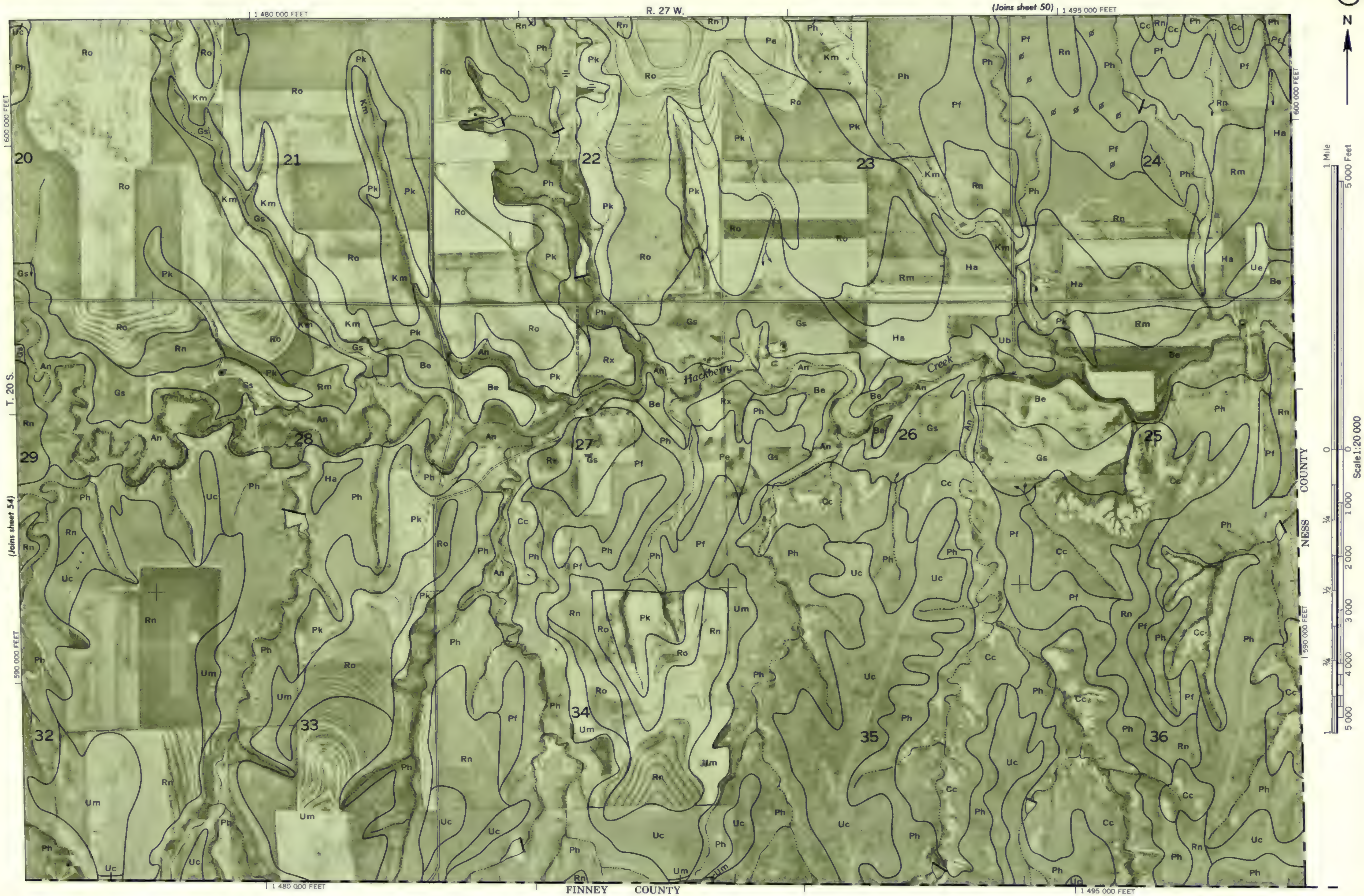


This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS — SHEET NUMBER 54

LANE COUNTY, KANSAS NO. 54

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

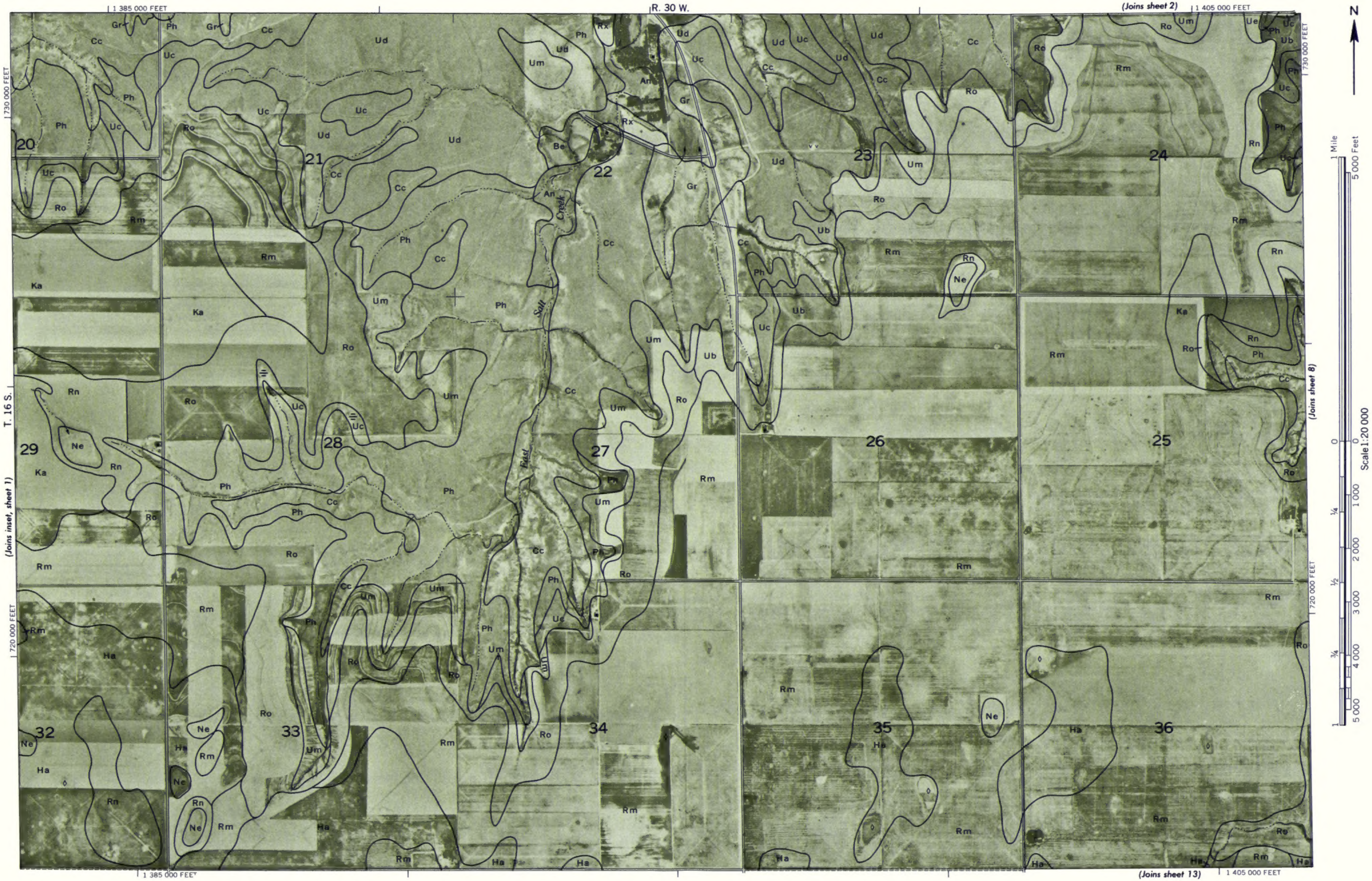
LANE COUNTY, KANSAS — SHEET NUMBER 6

LANE COUNTY, KANSAS NO. 6

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum

Land division corners are approximately positioned on this map.

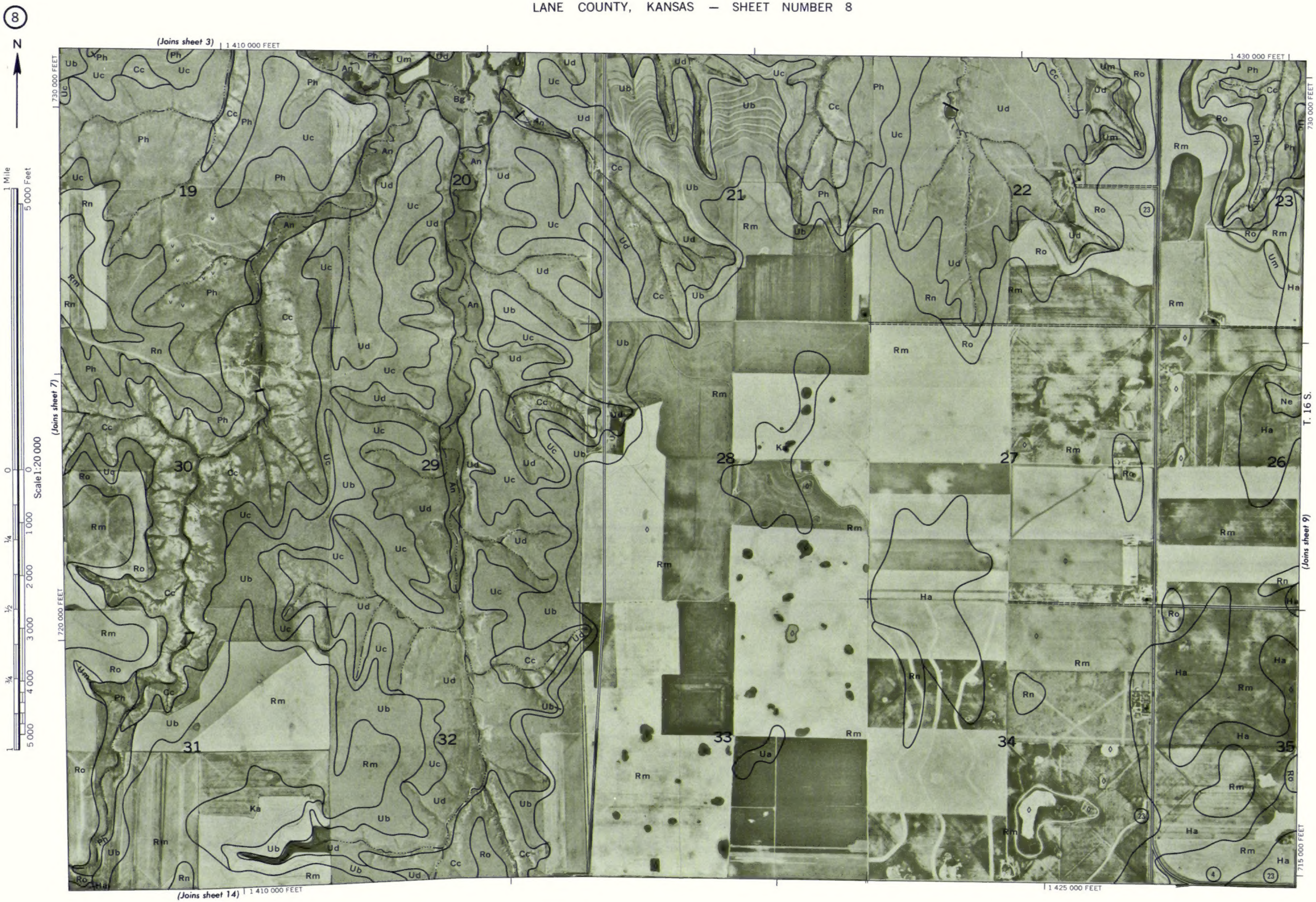
LANE COUNTY, KANSAS — SHEET NUMBER 7



This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 7

LANE COUNTY, KANSAS — SHEET NUMBER 8



LANE COUNTY, KANSAS NO. 8

This map is one of a set compiled in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Experiment Station. Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.

Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS — SHEET NUMBER 9

Thi map is one of a set mplied in 1970 as part of a soil survey by the United States Department of Agriculture, Soil Conservation Service, and the Kansas Agricultural Exp timent Station.
Photobase from 1965 aerial photographs. 5,000-foot grid ticks based on Kansas plane coordinate system, south zone. 1927 North American datum.
Land division corners are approximately positioned on this map.

LANE COUNTY, KANSAS NO. 9